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ERRATA

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Page 211, lines 17 and 18: Delete Type species, *H. coronatus* n. sp.
Page 269, line 16: For already read clearly.
Page 418, line 2 f. b: Insert ρ before r^2.
Page 421, line 5 of footnote 12: For $\rho_m \; \rho_2$ read $\rho_m - \rho_2$.
Page 425, line 5 f. b: For allow read allows.
Page 427, equation at bottom: For $\int^{\bar{r}}$ read $\int_{r}^{\bar{r}}$.

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PETROLOGY.—*The genesis of melilite.*[1] N. L. BOWEN, Geophysical Laboratory, Carnegie Institution of Washington.

In a recent paper the writer described some alnoitic rocks from Isle Cadieux, Quebec, that contain the mineral, monticellite. This was presumed to be the first recognition of monticellite as an igneous-rock mineral.[2] After the paper was published K. H. Scheumann called my attention to a mineral occurring in rocks of a related character from Polzen, Bohemia, of which mineral he has said: "Perhaps we are dealing with monticellite, whose occurrence in a rock so rich in magnesia would not be surprising, or perhaps with an olivine rich in the monticellite molecule." Scheumann's descriptions show that the mineral is, with little possible doubt, the same as that in the Canadian rocks and is to be regarded as monticellite even though his optical determinations were not sufficiently quantitative to establish its identity.[3] These observations of Scheumann's were not known to me nor were they recalled by any of the petrologists with whom I discussed the occurrence of monticellite in igneous rocks. Had the Polzen rocks been described under more familiar names such as alnoite, melilite basalt, with such qualifying terms as may have been necessary, they and their characters would not have escaped my notice in general abstract literature, but appearing under the disguise of locality names it is perhaps not surprising that they did not attract attention. Of this matter more later.

In the paper on the Cadieux rocks were included the results of some experimental work designed to throw light on the origin of some of the mineral phases present. Experiment showed that, in certain

[1] Received December 7, 1922.

[2] N. L. Bowen, Am. J Sci. III: 1–34. 1922.

[3] K. H. Scheumann. Konigl. sächs Gesell. d. Wiss. Abhandl. **32:** 7, 732–4. 1913.

mixtures of diopside and nephelite, diopside may separate early and then, by reaction with the liquid, be replaced by forsterite (olivine) and akermanite (melilite). This was in accord with the mineral paragenesis in the Cadieux rocks, and it was suggested that an alkaline (nephelite-rich) liquid reacted with augite to produce monticellite and melilite, acting, as it were, as a desilicating agent. It was suggested also that an analcite-rich liquid was produced by the reaction and that this gave rise to the analcite dikes.

Scheumann in a more recent paper discusses the application of these conclusions to the rocks of the Polzen region and decides that, while these reactions were in part responsible for the production of lime-rich minerals, especially melilite, yet addition of lime to the magma must be considered an important factor particularly in the production of monticellite. He suggests, too, that since melilite separates "in excess" it may later react with the liquid to reproduce pyroxene and of this reaction he finds evidence in the Polzen rocks.[4] In the artificial mixtures, no doubt, this reversal of the reaction with reformation of pyroxene and nephelite would occur at lower temperatures, but this fact cannot be demonstrated on account of the sluggishness of reaction. The reversal did not occur in the Cadieux rocks for the reason, as believed, that the reacting liquid was separated (squeezed out) and formed the analcite dikes. Even if it had not been separated, analcite might have persisted as a ground-mass mineral in the presence of melilite just as quartz may occur in the ground-mass of an olivine-bearing rock. The requisite condition is very rapid cooling. Though Scheumann accepts the formation of some melilite by the reaction method demonstrated experimentally, he nevertheless appears to be offering an objection to it when he says "Melilite rocks in which the more silicic alkaline residue has crystallized as analcite are unknown." With this very question in mind I have myself been examining a few melilite rocks, sections of which were readily obtainable. In two of these I have found analcite as typical interstitial, residual material. The one is the melilite-nephelite basalt of Moiliili, Oahu, Hawaiian Islands which has been described by Cross.[5] In places in this rock the interstitial material consists entirely of anhedra of nephelite but in other places it is a mixture of nephelite and analcite in which the nephelite occurs as euhedra in an analcite base and in which there can, therefore, be no question of the analcite being formed by alteration of the nephelite. The attack of the alkaline liquid on the augite is shown by the outlines of the augite "interlocking most irregularly

[4] Neues Jahrb., Centralbl. 1922: 495–545.

[5] W. Cross. U. S. Geol. Surv. Prof. Paper 88: 20–22. 1915.

with other minerals."[6] It is believed that the melilite was formed as a result of this attack though, admittedly, it does not occur in typical reaction-rim form.

The other melilite rock showing analcite is a melilite-nephelite basalt from pipe No. 3 E 5°S of Wolf Kraal House, Namaqualand.[7] It shows nephelite and analcite in the same relation as that described above, but the whole rock is much finer-grained than the Hawaiian example and the general relations of the minerals more obscure.

It is apparent, then, that analcite does occur as a residual mineral in some melilite rocks. In deep-seated rocks the reaction between nephelite and pyroxene to produce analcite and melilite is reversed. It is probable that some melilite is produced by the addition of lime to ordinary basalts, but when so formed one would expect it to be found in deep-seated rocks as commonly as in effusive and dike rocks. The fact that melilite is practically absent from deep-seated rocks suggests the dominance of the other method of production, namely, interaction of nephelite and pyroxene which requires the rapid cooling accompanying eruption in order to prevent its reversal at lower temperatures.

ROCK NAMES

It has been noted on a former page that polzenite and its characters escaped notice on account of its unfamiliar name, nevertheless it should be stated that polzenite is as much entitled to a new and distinctive name as many other rock types. It does seem, however, that the time has come to call a halt to the wholesale manufacture of rock names. Frequently these names designate only a slight departure in texture or in relative proportions of minerals from some common types with familiar names, and these variants could more profitably be described under the familiar names with appropriate modifying words or phrases. Such a procedure would undoubtedly result in many cumbersome names, but better a cumbersome name that immediately conveys the character of the rock to the reader than a concise name that conveys nothing but the locality where the rock happened to be first found.

Lest it be supposed that the objections raised are directed principally against the polzenite of Scheumann, I wish to cite an instance nearer home. I have just read in manuscript a paper on Hawaiian lavas by my colleague Doctor Washington, in which paper the names kohalaite, mugearite, and hawaiite are used to designate certain

[6] Cross. op. cit.: p. 21.

[7] Locality so described by A. W. Rogers on submitting specimen to H. S. Washington for analysis.

types. Following kohalaite is found, in brackets, oligoclase andesite, and following mugearite, olivine-oligoclase andesite. Would not these more familiar terms by themselves have been more desirable? One finds, too, that hawaiite is just an andesine basalt. Why not call it that and not perpetuate names that add to our already heavy burden?[8]

A comparatively few type names with appropriate qualifying words should be sufficient to designate all rocks. Occasionally names that are inconveniently cumbersome will result, but sodium para-dimethamino-azobenzene-para-sulphonate is an unwieldy name yet it thoroughly justifies itself by telling the chemist the nature and properties of the substance named.

We do not labor under the same difficulties as do the workers in biologic science, for it would be an impossible task to formulate a name for an oak tree that would give a clear picture of how it differs from a maple tree. But two rock types that have received wholly unrelated names may differ from each other merely in the presence or absence of a definite, concrete, crystalline phase, which fact could readily be expressed in the names applied to them.

The choice of names for rocks has an importance apart from that connected with convenience for use by petrologists themselves. It can scarcely be doubted that future advances in our knowledge of rocks must come in large part through the application of physics and chemistry to the problems which rocks present. This means the coöperation of the physicist and chemist with the petrologist, and this in turn necessitates a certain amount of respect for the petrologist and his science. But how can the physicist and chemist respect a man who continues to base the names of new rock types on nothing more fundamental than the name of the locality in which they are found?

Only the confirmed systematist can hope to keep abreast of the ever increasing multitude of rock names. In the meantime the one whose prime interest lies in other aspects of rocks, but who must keep informed of the newly discovered facts of petrology, has an unnecessary and almost insupportable burden placed upon him in the never-ebbing tide of pienaarite, tveitasite, modlibovite, damkjernite, ankaratrite, assyntite, muniongite, orendite, sviatoynossite, yamaskite, kauaiite, ghizite, and leeuwfonteinite.

De profundis clamavi.

[8] Since this was written Dr. Washington has made changes in his paper so that the above remarks apply only to his original manuscript. He has dropped the locality names and joined forces with me in criticism of them.

BOTANY.—*New species of plants from western Mexico.* PAUL C. STANDLEY, U. S. National Museum.[1]

Among the numerous collections of Mexican plants in the U. S. National Herbarium there are probably none of greater value and few equal in importance to those obtained by Prof. C. Conzatti during his many years of residence in the State of Oaxaca. At frequent intervals he has generously presented to the National Museum sets of specimens of his collections, mostly secured in Oaxaca, until now these amount to over four thousand sheets, which possess an added value because of the care with which they have been prepared. Almost every sending from Professor Conzatti includes at least a few undescribed plants, and always there are representatives of many rare and imperfectly known species. The list of distinct new plants discovered in Professor Conzatti's collections is already a long one, and there doubtless remain many more in the herbarium under groups which have not been studied critically.

Five of the species here proposed as new were contained in a small shipment of plants received last summer. This sending also included an exceptionally large number of rare species, many of which were known previously from a single collection. Several others of the plants probably represent new species, but they belong to groups in which it does not appear desirable to describe further novelties until critical revision can be undertaken. There is published here also a description of a new species of *Caesalpinia* from Sinaloa, and a tree previously described as a *Pithecollobium* is transferred to a more natural position in the genus *Albizzia.*

Allionia grandiflora Standl., sp. nov.

Stems slender, branched, densely short-pilose throughout, the pubescence viscid above; petioles slender, 5–12 mm. long, short-pilose, the blades ovate to broadly ovate, 3–5 cm. long, 2–3 cm. wide, acuminate, rounded or obtuse at base, thin, densely short-villous on both surfaces; involucres mostly in terminal one-sided cymes, short-pedunculate, 1-flowered, about 1 cm. long, densely villous, the lobes lanceolate, acuminate; perianth magenta, 2.5–3 cm. long, densely pilose below, glabrate above, the tube 1.5–2 cm. long and 3 mm. thick; stamens included; fruit (immature) 7 mm. long, constricted near the base, minutely puberulent, the 5 ribs broad and nearly smooth.

Type in the U. S. National Herbarium, no. 1,110,839, collected on the Cerro Jucusá, Tututepec, Oaxaca, Mexico, altitude 240 meters, Dec. 13, 1921, by C. Conzatti (no. 4449).

In general appearance this plant resembles a *Mirabilis*, but it possesses

[1] Published by permission of the Secretary of the Smithsonian Institution. Received December 1, 1922.

the technical characters of the genus *Allionia*. It is not closely related to any previously known species, its most distinctive character being the large perianth.

Albizzia tomentosa (Micheli) Standl.
Pithecollobium tomentosum Micheli, Mém. Soc. Phys. Hist. Nat. Genève **34**: 285. *pl. 28*. 1903.

In a recently published part of a volume upon the woody plants of Mexico,[2] some doubt was expressed by the writer as to the proper generic position of the tree described by Micheli as *Pithecollobium tomentosum*. When the manuscript for the treatment of the genus was prepared, fruiting material of this species was not available. Specimens with both fruit and flowers, collected recently in the State of Sinaloa, Mexico, by Mr. Jesús G. Ortega (no. 4554), indicate that the proper place of the tree is in the genus *Albizzia*. The fruit is flat, about 11 cm. long and 2 cm. wide, and has thin, elastically dehiscent valves. The vernacular name used in Sinaloa is "palo joso."

Caesalpinia ortegae Standl., sp. nov.
Branchlets densely covered with stipitate black glands; leaves long-petiolate, the petioles and rachis covered with stipitate glands; pinnae usually 3 pairs, the leaflets 7 or 8 pairs, oblong, 6–11 mm. long, 2.5–4 mm. wide, rounded at apex, thinly pilose with short slender stiff whitish subappressed hairs, beneath copiously furnished with sessile black glands; racemes elongate, densely covered on the rachis, pedicels, and calyx with black stipitate glands and also pilosulous with short spreading white hairs, the pedicels 5–10 mm. long, articulate below the middle; sepals entire; petals about 1 cm. long; fruit elastically dehiscent, flat, densely covered with short-stipitate black glands, falcate, about 6 cm. long and 1.2 cm. wide; seeds strongly compressed, rounded-obovate, 7–8 mm. long.
Type in the U. S. National Herbarium, no. 1,083,885, collected in the State of Sinaloa, Mexico, by Jesús G. Ortega (no. 890).

Well distinguished from the related Mexican species by the extraordinary abundance of stipitate glands on all parts of the plant. It is a pleasure to be able to name so well-marked a species in honor of its collector, who during the past few years has made many valuable contributions to the knowledge of the Sinaloan flora.

Amyris conzattii Standl., sp. nov.
Branchlets slender, grayish, glabrate; leaves alternate, the rachis slender, 4–7 cm. long, thinly puberulent, the leaflets about 21, rhombic or ovate-rhombic, 6–12 mm. long, 3–8 mm. wide, obtuse or rounded at apex, very oblique at base, entire or obscurely crenulate, glabrous or sometimes sparsely puberulent above, with very numerous large glands; flowers in lax terminal glabrous panicles, the fruiting pedicels 5–10 mm. long; drupes globose, 8–10 mm. in diameter, the pericarp filled with large and conspicuous oil glands.
Type in the U. S. National Herbarium, no. 1,110,840, collected at Los Sabinos, between Juchatengo and Santa Ana, Oaxaca, Mexico, altitude 1,000 meters, Dec. 29, 1921, by C. Conzatti (no. 4556).

[2] Contr. U. S. Nat. Herb. **23**: 397. 1922.

In the key to the species of *Amyris* by Percy Wilson in the North American Flora (**25**: 216. 1911), this plant runs at once to *A. texana* (Buckl.) P. Wils., a species occurring in Texas and northeastern Mexico, but with trifoliolate leaves. *Amyris conzattii* is not closely related to any of the species previously known from North America.

Schaefferia oaxacana Standl., sp. nov.

Branches greenish, striate-angulate, glabrous; leaves mostly fasciculate, oblong-spatulate or oblong-obovate, 1–2 cm. long, 4–8 mm. wide, rounded or emarginate at apex, cuneately narrowed at base to a very short petiole, glabrous, pinnately nerved, the costa prominent, the lateral nerves ascending at a very acute angle, inconspicuous; flowers solitary or fasciculate at the nodes, on stout pedicels 1.5–2.5 mm. long; fruit oval, 2-celled, about 8 mm. long.

Type in the U. S. National Herbarium, no. 1,110,837, collected near the Cumbre de las Calaveras, Distrito de Zimatlán, Oaxaca, Mexico, altitude 2,200 meters, Nov. 27, 1921, by Conzatti (no. 4325).

The only related species is *S. cuneifolia* Gray, a native of Coahuila and Texas. In that the branchlets are short, stiff, divaricate, and often spinose, while in *S. oaxacana* they are long, slender, ascending, and not spinose, differences which give quite different aspects to the two species. In the Texan plant, moreover, the fruits are much smaller and sessile.

Bouvardia oaxacana Standl., sp. nov.

Branchlets slender, terete, glabrous or minutely puberulent about the nodes; stipule sheath 2–3 mm. long, puberulent, the lobes obtuse, cuspidate; leaves opposite, the petioles puberulent, equaling or shorter than the stipules, the blades ovate or broadly ovate, 4–6 cm. long, 2–4 cm. wide, acuminate, broadly rounded at base, thin, sparsely puberulent or glabrate, conspicuously 5-nerved, the lateral nerves arcuate and extending nearly or quite to the apex; inflorescence terminal, cymose-corymbose, dense, many-flowered, the pedicels 2–4 mm. long, hirtellous; hypanthium hirtellous; calyx lobes linear-lanceolate, 5–9 mm. long, puberulent; corolla red, glabrous outside, the tube about 17 mm. long, the lobes oblong, 5 mm. long, obtuse, glabrous; anthers about equaling the corolla lobes; style not exserted.

Type in the U. S. National Herbarium, no. 1,110,842, collected between Santa Cruz and El Aguacate, Distrito de Juquila, Oaxaca, Mexico, altitude 500 meters, Dec. 24, 1921, by C. Conzatti (no. 4513).

Related to *B. quinquenervata* Standl., of Chiapas, which is distinguished by its small corolla and shorter, narrower calyx lobes. In one of the specimens of *B. oaxacana* the corolla is sparsely puberulent, but this probably represents an unimportant variation from the typical form with glabrous corolla.

Chomelia barbata Standl., sp. nov.

Plants unarmed, the branchlets slender, appressed-pilose; stipules 3 mm. long, deltoid, cuspidate, appressed-pilose outside; petioles slender, 5–8 mm. long, puberulent; leaf blades elliptic or rounded-elliptic, 3.5–5.5 cm. long, 2–3.5 cm. wide, obtuse or acutish, rounded to acute at base, glabrous above except along the costa, beneath densely barbate along the costa, elsewhere

puberulent or glabrate, the lateral nerves inconspicuous; cymes lateral, dense, few-flowered, the peduncles very slender, 2.5–3.5 cm. long, pilosulous with whitish subappressed hairs; flowers sessile or subsessile, ebracteolate, obscurely or not at all secund; hypanthium and calyx cylindric, 2–2.5 mm. long, appressed-pilosulous, the lobes minute, obtuse; corolla densely appressed-pilosulous outside, the slender tube 15 mm. long, the lobes oblong-ovate, obtuse, 2.5 mm. long; anthers semiexserted; fruit white, 2-celled, oblong, glabrate, 1–1.5 cm. long.

Type in the U. S. National Herbarium, no. 1,110,841, collected in the vicinity of Chacahua, Distrito de Juquila, Oaxaca, Mexico, altitude 5 meters, Dec. 17, 1921, by C. Conzatti (no. 4475).

Related to *C. microloba* Donn. Smith, of Costa Rica, which differs in its small flowers and scant pubescence.

ZOOLOGY.—*A revision of the recent representatives of the crinoid family Pentacrinidæ, with the diagnoses of two new genera.*[1] AUSTIN H. CLARK, National Museum.

A detailed study of the recent representatives of the crinoid family Pentacrinidæ shows that these are by no means so closely allied to the fossil species in the same family as has been supposed. None of them can be considered as congeneric with *Isocrinus pendulus* with which most of them have been associated, and their relationships with other fossil types are still more remote.

The following disposition of the living forms is suggested.

KEY TO THE RECENT GENERA OF PENTACRINIDÆ

a^1 Second post-radial ossicle not an axillary
- b^1 fourth post-radial ossicle an axillary ... *Saracrinus*
- b^2 first axillary beyond the fourth post-radial ossicle ... *Metacrinus*

a^2 Second post-radial ossicle an axillary from which two arm trunks arise
- b^1 elements of the IBr series (the first two post-radial ossicles) united by syzygy
  - c^1 at least the outer division series of more than 6 elements; proximal pinnules with a strongly serrate profile ... *Cenocrinus*
  - c^2 none of the division series of more than 4 elements; proximal pinnules with a smooth profile
    - d^1 division series beyond the first entirely, or at least mostly, of more than 2 elements
      - e^1 division series beyond the first variable, but never 3(1+2); distal edges of the post-radial ossicles everted and produced ... *Teliocrinus*
      - e^2 all the division series beyond the first 3(1+2); distal edges of the post-radial ossicles not produced ... *Endoxocrinus*

[1] Received December 6, 1922.

d^2 all of the division series 2(1+2)

e^1 cirri long and stout, composed of more than 20 (usually more than 30) segments, the whorls of cirri being separated by 1–10 pentagonal to bluntly stellate internodals

Diplocrinus

e^2 cirri short, consisting of about 18 segments, the whorls separated by 30–40 or more rounded internodals

Annacrinus

b^2 elements of the IBr series not united by syzygy

c^1 more than 10 arms

Neocrinus

c^2 ten arms only

Hypalocrinus

Genus Metacrinus P. H. Carpenter

Metacrinus P. H. CARPENTER, Bull. Mus. Comp. Zoöl., vol. 10, No. 4, 1882, p. 167 (no species included).—P. H. CARPENTER, "Challenger" Reports, Zoölogy, vol. 11, part 32, 1884, p. 344.

Diagnosis.—A genus of Pentacrinidæ in which the first axillary is beyond the fourth, and is usually the seventh, post-radial ossicle.

Genotype.—*Metacrinus wyvillii* P. H. Carpenter, 1884 (cf. A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 527).

Geographical range.—From southern Japan to the Kermadec Islands and southeastern Australia, and westward to the Kei Islands.

Bathymetrical range.—From 119 to 1133 meters.

Included forms.—*Metacrinus costatus* P. H. Carpenter, *M. cyaneus* H. L. Clark, *M. interruptus* P. H. Carpenter, *M. moseleyi* P. H. Carpenter, *M. nodosus* P. H. Carpenter, *M. rotundus* P. H. Carpenter, *M. stewarti* P. H. Carpenter, *M. wyvillii* P. H. Carpenter, and *M. zonatus* A. H. Clark.

Saracrinus, gen. nov.

Diagnosis.—A genus of Pentacrinidæ in which the fourth post-radial ossicle is the first axillary.

Genotype.—*Metacrinus nobilis* P. H. Carpenter, 1884.

Geographical range.—From the Korean Straits and the Bonin Islands to the Kermadec Islands and southeastern Australia,[2] and westward to Sumatra.

Bathymetrical range.—From 55 to 1133 meters.

Included forms.—*Saracrinus acutus* (Döderlein), *S. angulatus* (P. H. Carpenter), *S. batheri* (A. H. Clark), *S. batheri* var. *gracilis* (A. H. Clark), *S. cingulatus* (P. H. Carpenter), *S. nobilis* (P. H. Carpenter), *S. nobilis* var. *borealis* (A. H. Clark), *S. nobilis* var. *murrayi* (P. H. Carpenter), *S. nobilis* var. *nobilis* (P. H. Carpenter) (= var. *typica* [Döderlein]), *S. nobilis* var.

[2] It is evident from Dr. H. L. Clark's description of *Metacrinus cyaneus* (Biol. Results Fishing Experiments F. I. S. "Endeavour," vol. 4, part 1, 1916, p. 9) that some of his specimens belonged to a species of this genus; the figure, however, represents a true *Metacrinus*.

sumatranus (Döderlein), *S. nobilis* var. *tenuis* (Gislén), *S. nobilis* var. *timorensis* (Döderlein), *S. nobilis* var. *tuberculatus* (A. H. Clark), *S. serratus* (Döderlein), *S. superbus* (P. H. Carpenter), *S. suluensis* (Döderlein), *S. tuberosus* (P. H. Carpenter), and *S. varians* (P. H. Carpenter).

Genus Cenocrinus Wyville Thomson

Cenocrinus WYVILLE THOMSON, The Intellectual Observer, vol. 6, No. 31, August 1864, p. 2.

Diagnosis.—A genus of Pentacrinidæ in which the first two post-radial ossicles are united by syzygy and the second is axillary, the following division series consist of numerous segments, more than 6 in the outermost, and the segments of the proximal pinnules have strongly projecting distal angles so that these pinnules have a strongly serrate outline.

Genotype.—*Pentacrinites caput-medusæ* Miller, 1821 (= *Encrinus caput-medusæ* Lamarck, 1816 = *Isis asteria* Linné, 1766).

Geographical range.—West Indies; Cuba to Barbados.

Bathymetrical range.—From shallow water (it has been found on the beach at Barbados) to 585 meters.

Included species.—*Cenocrinus asteria* (Linné).

Remarks.—Although this species, which is so frequently figured in text-books, was first described by Guettard so long ago as 1761, and by Ellis in 1762, only sixteen specimens of it have so far come to light; but three undetermined specimens mentioned by early writers may also belong to it.

Genus Teliocrinus Döderlein

Teliocrinus DÖDERLEIN, Wiss. Ergebn. d. deutsch. Tiefsee Exped., vol. 17, Heft 1, 1912, p. 22.

Comastrocrinus A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 252.

Diagnosis.—A genus of Pentacrinidæ in which the first two post-radial ossicles are united by syzygy and the second is axillary, the division series beyond the first are variable, but never of 3(1+2), rarely of two, and never of more than six elements, and the ossicles of the division series and brachials have everted and strongly produced distal borders.

Genotype.—*Teliocrinus asper* Döderlein, 1912 (= *Hypalocrinus springeri* A. H. Clark, 1909).

Geographical range.—From western Sumatra northward to the Gulf of Martaban and westward to the Laccadive Islands and the western coast of India.

Bathymetrical range.—From 366 to 1280 meters.

Included forms.—*Teliocrinus liliaceus* (A. H. Clark), *T. ornatus* (A. H. Clark), and *T. springeri* (A. H. Clark) (= *T. asper* Döderlein).

Genus Endoxocrinus A. H. Clark

Endoxocrinus A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 151.—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 35, 1908, p. 131.

Diagnosis.—A genus of Pentacrinidæ in which the first two post-radial ossicles are united by syzygy and the second is axillary, all the following division series are 3(1+2), and the first two brachials are united by syzygy.

Genotype.—*Encrinus parræ* Gervais, 1835 (= *Encrinus milleri* Guilding, 1828 [not *Encrinites milleri* von Schlotheim, 1822] = *Pentacrinus mülleri* Oersted, 1856).

Geographical range.—West Indies; Cuba to St. Vincent.

Bathymetrical range.—From shallow water (whence it is occasionally brought up by fishermen) down to 526 meters.

Included species.—*Endoxocrinus parræ* (Gervais).

Remarks.—In the "Challenger" report Carpenter confused this species with *Diplocrinus maclearanus* and his account of "*Pentacrinus mülleri*" is based upon specimens of both species. This explains the discrepancy between the original diagnosis of *Endoxocrinus* and the characters of the type species, and also Döderlein's confusion regarding *parræ* at the time he proposed the genus *Diplocrinus*.

Genus Diplocrinus Döderlein

Diplocrinus DÖDERLEIN, Wiss. Ergebn. d. deutsch. Tiefsee Exped., vol. 17, Heft 1, 1912, p. 21.

Diagnosis.—A genus of Pentacrinidæ in which all of the division series are 2(1+2), the first two brachials are united by syzygy, and the cirri are long and stout with more than 20 (usually more than 30) segments, the whorls being separated by 1–10 pentagonal to stellate internodals.

Genotype.—Here designated as *Pentacrinus maclearanus* Wyville Thomson, 1877.

Geographical range.—From Florida to Brazil, and from Timor to the Philippine and Meangis Islands.

Bathymetrical range.—From 154 to 1097 meters.

Included forms.—*Diplocrinus alternicirrus* (P. H. Carpenter), *D. maclearanus* (Wyville Thomson), and *D. sibogæ* (Döderlein).

Annacrinus, gen. nov.

Diagnosis.—A genus of Pentacrinidæ in which all of the division series are 2(1+2), the first two brachials are united by syzygy, and the cirri are short with about 18 segments the whorls being separated by 30–40 or more rounded internodals.

Genotype.—*Pentacrinus wyville-thomsoni* (Jeffreys, *nomen nudum*) Wyville Thomson, 1872.

Geographical range.—From the Bay of Biscay to Morocco and the Canary Islands.

Bathymetrical range.—From 1330 to 2002 meters.

Included species.—*Annacrinus wyville-thomsoni* (Wyville Thomson).

Genus Neocrinus Wyville Thomson

Neocrinus WYVILLE THOMSON, The Intellectual Observer, vol. 6, No. 31, August 1864, p. 7.

Diagnosis.—A genus of Pentacrinidæ in which the first two post-radial ossicles are united by synarthry and the second is axillary; IIBr and often further division series are present.

Genotype.—*Pentacrinus decorus* Wyville Thomson, 1864.

Geographical range.—West Indies; from Florida to Grenada.

Bathymetrical range.—From shallow water (sometimes brought up on Fishermen's lines) down to 1219 meters.

Included forms.—*Neocrinus blakei* (P. H. Carpenter), and *N. decorus* (Wyville Thomson).

Genus Hypalocrinus A. H. Clark

Hypalocrinus A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 152.—A. H. Clark, Proc. U. S. Nat. Mus., vol. 35, 1908, p. 130.

Diagnosis.—A genus of Pentacrinidæ in which the first two post-radial ossicles are united by syzygy and the second is axillary; there is no further arm division.

Genotype.—Pentacrinus naresianus P. H. Carpenter, 1882.

Geographical range.—From the Kermadec Islands and Fiji to the Philippines and Celebes.

Bathymetrical range.—From 621 to 2468 meters.

Included species.—Hypalocrinus naresianus (P. H. Carpenter).

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

166TH MEETING

The 166th meeting of the ACADEMY was held jointly with the Chemical Society of Washington (Local Section of the American Chemical Society) in the Assembly Hall of the Cosmos Club, the evening of Thursday, March 16, 1922. Dr. R. B. MOORE, Chief Chemist, Bureau of Mines, delivered an illustrated lecture, entitled, *The rare gases: Their history, properties, and uses.*

The lecturer gave first an outline of the history of the discovery of the rare gases. The first one, argon, was discovered jointly by Ramsay and Raleigh, due to an investigation by them of the difference in the density of nitrogen obtained from the air and from other sources. The discovery of helium was based on the observation of Dr. W. F. Hillebrand in 1888 that certain uranium minerals on heating or on solution in acid gave off gases, a considerable proportion of which appeared to be nitrogen. Ramsay showed that the residual gas, instead of being pure nitrogen, contained helium. Neon, krypton, and xenon were discovered by Ramsay and Travers through the fractionation of liquid air.

The physical properties of the elements were described, and their occurrence in nature fully gone into. Of special interest is the occurrence of helium not only in certain minerals and in the gases from springs, but also in natural gases from certain localities in the United States. The gases from some of the springs in France are particularly rich in helium, going as high as 10 per cent by volume. On the other hand, whereas the per cent in natural gas is not nearly so large (the maximum amount being about 1.8 per cent helium), the total volume of helium available is immense in proportion to that obtained from springs.

The origin of the rare gases was discussed, particularly the probable origin of helium: The latter may either come from radioactive changes or, assuming the Nebular hypothesis, from the atmosphere of the sun or the disintegration of supposedly non-radioactive elements, the alpha particle having a velocity below what is required for the ionization of gases.

The commercial production of helium, argon, and neon was described, and the Government project for the production of helium from natural gas for use in dirigibles and balloons was gone into in some detail. The early work in connection with the three experimental plants during the war and the development of the project since that time were fully described.

167TH MEETING

The 167th meeting of the ACADEMY was held jointly with the Philosophical Society of Washington and the Chemical Society of Washington in the Assembly Hall of the National Museum, the evening of Wednesday, March 29, 1922. Dr. F. W. ASTON, of Cambridge University, England, delivered an illustrated address on *Isotopes and the structure of the atom.*

The experimental study of radioactive elements led to the new and revolutionary conclusion that elements might exist which were chemically identical but which differed in radioactive properties and even in atomic weight. This idea has been strongly supported by the results of positive ray analysis,

which show that many of the non-radioactive elements may exist in two or more forms having practically identical chemical and spectroscopic properties but with different atomic weights. Such substances are called isotopes, because they occupy the same place in the periodic table of the elements.

The speaker described his mass spectrograph, which he has employed with great effectiveness in the detection of isotopes. The positively charged ions of the element under examination are projected first through an electric field and then through a magnetic field, impinging finally upon a photographic plate. If the element under examination consists of two isotopes, two lines or bands appear in the spectrum, the position of the line being determined by the mass of the isotope. Thus, boron (atomic weight 10.9) has two isotopes with masses 10 and 11; magnesium (atomic weight 24.32) has three isotopes with masses 24, 25, and 26. Fifteen or more of the non-radioactive elements have thus been shown to be isotopic mixtures, while others give no evidence of such complexity.

An excellent account of Dr. Aston's brilliant work in this field, for which he has recently been awarded the Nobel prize, may be found in his book on Isotopes.

168th meeting

The 168th meeting of the Academy was held jointly with the American Institute of Electrical Engineers (Washington Section) in the Assembly Hall of the Cosmos Club, the evening of Thursday, May 18, 1922. Dr. A. Van Dyck, of the General Electric Company, delivered an address on *The vacuum tube in present day radio.*

Doctor Van Dyck first outlined the fundamental relations between current and voltage within the electron tube or "triode," and showed how the presence of a minute charge of electricity on the grid could control the flow of much larger currents to the plate. Such tubes are useful as rectifiers, detectors, amplifiers, and modulators. He then showed a large number of slides illustrating the astonishing development of the electron tube during the past few years, and the huge scale on which it is now being applied in radio-telegraphy and -telephony, as well as to the extension of the range of wire telephony. Many of the slides illustrated the elaborate equipment installed in the high-power radio-telephone broadcasting stations.

169th meeting

The 169th meeting of the Academy was held jointly with the Medical Society of the District of Columbia and the Society of American Bacteriologists Washington Branch) in the Auditorium of the Medical Society, the evening of Tuesday, September 19, 1922. Dr. K. F. Meyer, Acting Director of the Hooper Foundation, delivered a lecture, entitled, *A summary of the studies on B. botulinus conducted at the Hooper Foundation for Medical Research, University of California.*

The address was illustrated with lantern slides, and included a description of the methods employed and a statement of the results obtained in an intensive study of this subject lasting more than two years Among the subjects discussed were: Distribution of *B. botulinus* in nature; the conditions under which it will grow; the biochemical activities of *B. botulinus;* the relation of toxin formation to the growth curve of the micro-organism and to physical evidence of spoilage of the food; heat resistance of *B. botu-*

linus; epidemiology of botulism. The detailed results of the investigation are given in a series of articles that are appearing in the Journal of Infectious Diseases.

170TH MEETING

The 170th meeting of the ACADEMY was held jointly with the Biological Society of Washington and the Chemical Society of Washington in the Assembly Hall of the Cosmos Club, the evening of Thursday, October 19, 1922. Dr. H. J. HAMBURGER, Professor of Physiology, University of Groningen, Holland, delivered an address, entitled, *The increasing significance of chemistry in medical thought and practice.*

Doctor HAMBURGER reviewed briefly the contributions of the older schools of thought to the chemical aspects of medicine, dwelling particularly upon the experiments of Paracelsus. In these early contributions there can be seen the first faltering steps in the construction of a mechanistic physiology. With the advent of modern chemical experimentation many of the bodily processes which had been regarded as under "vitalistic" control were shown to be under the control of such clearly defined forces as those of osmosis, electrolytic dissociation, and specific chemical reactions.

The complexity of the problem faced by the chemist is illustrated by the proteins. The chemist has isolated and identified the amino-acids of which the proteins are composed and he has shown how these, like bricks, may be put together to form an infinite variety in protein architecture. He has actually synthesized proteins of immense molecular weight, and although he can not fomulate the detailed structures of the infinite variety of proteins found in nature he can account for the variety demonstrated by the delicate reactions of immunology.

Of late it has been shown that the body forms substances which, circulating in the blood, act as messengers to control various processes. Two of these have been identified chemically and many more are known by their physiological action. The presence or absence of one or another of these so-called hormones may determine a specific set of characteristics. For instance, it has been experimentally demonstrated that the sex of a young animal may be altered by the removal of the ovaries and the implantation of testes.

As each contribution of chemistry is applied in medicine, the case for the mechanistic physiology becomes stronger.

WILLIAM R. MAXON, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The President has withdrawn from settlement three groups of prehistoric towers in southwestern Colorado and southeastern Utah. These are known as the ruins in Ruin Canyon, Holly Canyon, and Cool Spring House on Cajon Mesa. It is proposed that these groups be made a National Monument.

On the occasion of the meeting of the Trustees of the Carnegie Institution of Washington on December 14 a reception and exhibition of apparatus and methods were held at the Administration Building of the Institution.

The Pick and Hammer Club met at the U. S. Geological Survey on Saturday, December 2. Dr. F. E. WRIGHT spoke on geology in South Africa.

At the meeting of the Physics Club of the Bureau of Standards on December 11, Dr. J. C. KARCHER reported briefly on the papers on acoustics presented at the Chicago meeting of the American Physical Society, December 1-2, 1922.

The following public lectures have been given under the auspices of the Carnegie Institution of Washington: November 28. THOMAS HUNT MORGAN, professor of experimental zoology, Columbia University: *The constitution of the hereditary material and its relation to development.* December 5. HENRY NORRIS RUSSELL, director of the Princeton University Observatory: *The properties of matter as illustrated in the stars.* December 12. WALTER S. ADAMS, acting director of the Mount Wilson Observatory: *The motions of the stars.*

Dr. PENTTI ESKOLA, who has been engaged in research work at the Geophysical Laboratory, Carnegie Institution of Washington, for the past eighteen months, has returned to Finland to resume his work for the Geological Survey of that country.

Dr. CHARLES W. GILMORE has returned to his duties in the Department of Paleontology, U. S. National Museum, after a two months' absence at the University of Alberta, Edmonton, Canada.

Dr. JOHN B. HUNTER, professor of anatomy at the University of Sidney, Australia, visited Washington in December.

Dr. A. SOMMERFELD of the University of Munich, Germany, will deliver a course of lectures on general quantum theory at the Bureau of Standards early in March.

Dr. P. V. WELLS of the Optics Division of the Bureau of Standards resigned on December 1 to take up research work for the E. I. du Pont de Nemours Company, Parlin, New Jersey.

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PHYSICS.—*Notes on the electric heating of calorimeters.*[1] Walter P. White. Geophysical Laboratory, Carnegie Institution of Washington.

Various systematic errors in calorimetry, especially those in the difficult heat capacity determination, are diminished or removed if the calorimeter is used to compare two thermal quantities, one of which is a standard. It now seems that such comparison methods, with rare exceptions, should be regarded as the normal thing in accurate calorimetry..

A fundamental standard should be above suspicion, hence the standard adopted should possess to the full the precision of the *comparative* calorimetric measurements. This is much higher than may generally be recognized. More than ten years ago calorimeters in two different laboratories showed a precision, i.e., an agreement, of 20 to 30 per million. It will hardly do to assign such a value for the probable final accuracy of a calorimetric experiment at present, but it is possible, under favorable conditions often attainable, and with no great amount of adjustment or experimenting, to secure, as far as the calorimeter itself is concerned, a precision of 100 per million, which would usually mean a like final accuracy if a comparison method is used. The standard for comparison should be safely more accurate than this, say to 30 per million.

Except in certain specific heat determinations, this standard of comparison must be a quantity of heat. Of the two available standards, mechanical and electric, the electric is unquestionably of preponderant practical value. It is really the standard in most cases at the

[1] Received December 20, 1922.

present time,[2] while it vies with heat of chemical reaction as a convenient secondary standard.

The present paper deals with some features of electric standardization which need attention in working to 30 per million.

It seems proper to take as the standard form of electric heating the well known method of measuring the time, the current through the heating coil, and the voltage drop across it; hence, for instance, if the resistance of the coil is used directly, it is to be measured between points which would be suitable for the attachment of the potential leads in the standard method. It is often desirable to make the time of heating as short as 3 minutes.

The special topics to be treated here are: I, the conduct of the determinations, and, II, the error from heat produced in the leads. In conducting the determinations it is necessary to deal with: A, the variety of observations, and B, the variations in the heating currrent.[3]

I, A. Management of the Observations

A second observer, with complete apparatus, can take care of the electric energy readings, including the time, so that the calorimeter can be observed as usual. A single practised observer, with good apparatus, can also do all the work alone if the calorimeter temperature is read electrically; most simply if a potentiometer can be used for all the measurements. A superior method, however, for fluid-filled calorimeters and heatings not over 5 minutes long, is to calculate the average calorimeter temperature during the heating, by means of observations made immediately before and after. It evidently makes the second observer quite superfluous, and enables a single one to give more complete attention to the energy readings. It therefore seems to deserve examination.

[2] To define the calory electrically, (as, say, 4.183 joules), is really only to recognize a situation already existing. Such recognition, as soon as it becomes general, will put an end to the use of the needless multiplicity of "calories" (15-degree calory; 20-degree calory, etc.) which now inconveniences us, since the only excuse for more than one standard is uncertainty as to the exact ratio between values determined by means of water at different temperatures. Few, if any existing results obtained in water-derived calories are accurate enough to suffer appreciable loss of accuracy through restatement in electric calories, while electrically derived results might often lose by the opposite transformation.

All this is aside from the question whether heat is to be stated in terms of calories of approximately 4.183 joules, or in joules directly.

[3] More difficult is knowing the values of the auxiliary resistance coils concerned in the energy measurement. This, however, has been adequately treated elsewhere.

Indirect Method for Finding the Thermal Head

The conditions on which the calculation method has to be based are as follows:

It will be convenient to treat first the case where the thermal head is practically zero at the beginning of the heating. If OA in fig. 1 represents the course of the calorimeter temperature before the heat is turned on at the time of A, for the time T, $= AB'$, then ABM may represent the temperature corresponding to the energy which has been given to the calorimeter. The temperature read is caused to vary from this simple scheme by two things, first the lag, and then the thermal leakage. The lag alone would make the temperature follow the line $AEFG$, which, if the lag is not unusually large, may with quite negligible error be taken as coincident between two points, E and F, with a line CD, parallel to AB, and at a point G with BM. Then the horizontal distance AC, $= BD$, represents the time L_H, the lag of the calorimeter temperature behind the energy supply. The shaded areas ACE and FDG are equivalent, hence the mean temperature and consequently the mean thermal head will be just the same if the line followed is $ACDM$, and this will be taken as the result of the heating.

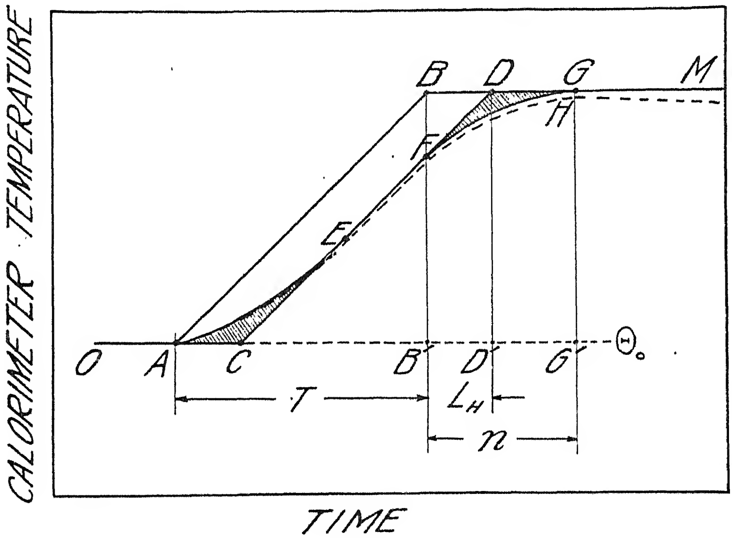

Fig. 1

This temperature pattern is further modified by the thermal leakage which it itself causes. The modification is merely a fall of temperature everywhere proportional to the actual thermal head, and giving that when superposed on the pattern $ACDM$.

For calculating this, the only measurements needed during the calibration are two, of calorimeter temperature or thermal head, one before the heat is started, the other long enough after its end to allow the difference between the converging lines DG and FG to become negligible. These data may then be used in accordance with the result of the following demonstration:

If q is the temperature rise corresponding to the heat supplied per minute, A the jacket temperature, and K the leakage modulus,[4] the temperature, neglecting lags, is easily shown to be:

$$\theta = \frac{q}{K} + A + \left(\theta_o - \frac{q}{K} - A\right)e^{-Kt} \qquad (1)$$

It will be convenient to write the exponential as a series, giving:

$$\theta = \theta_o + \left\{q - (\theta_o - A)\, K\right\} t \left(1 - \frac{Kt}{2} + \frac{K^2t^2}{6} - . +\right) \qquad (2)$$

$\theta_o - A$ is O in the present case. Since this expression for calorimeter temperature is to be multiplied by K to get the temperature change due to thermal leakage, then for water-filled calorimeters, where K is seldom much over 0.003, the terms now containing K^2 and higher powers will contain a factor of 0.000,000,027 t^3 or less, and may be neglected unless t is uncommonly large. Similarly other terms containing K^2 will be omitted later. The physical meaning of the omission is this: In defining the temperature pattern, which is to be multiplied afterward by the very small factor KT, we will take account of the change in temperature due to the leakage produced by the impressed temperature, but find negligibly small the change in the leakage caused by the change due to the leakage.

If n denotes the time from the end of the heating to the first direct thermal head measurement afterward, represented by BG, then the time from D to G is $n - L_H$. Thermal head is the same as the temperature rise above θ_o since it was taken as zero for $\theta = \theta_o$. On account of thermal leakage, the temperature after $T + L_H$ minutes is not $D'D$ which equals qT but, by (2) $qT - qT\,\frac{KT}{2}$; and after $n - L_H$ minutes more is still lower, or, say, $G'H$. This is the temperature actually observed. Then the *true* integrated thermal head, $\phi T''$,

[4] Thermal leakage modulus, temperature fall per minute per degree of thermal head. Thermal head, mean effective temperature difference between calorimeter surface and surroundings.

to the time of G is the head during the temperature rise plus that during the approach of equilibrium, or:

$$\phi\, T' = \int_0^T \left(qt - qt\,\frac{Kt}{2}\right) dt + \left[qT - \frac{qKT^2}{2}\right] \int_0^{n-L} (1 - Kt)\, dt$$

which gives for the true integrated thermal head for the interval $T + n$:

$$\phi\, T' = qT \left\{\frac{T}{2} - \frac{KT^2}{6} + (n - L) - \frac{KT}{2}(n - L) - \frac{K}{2}(n - L)^2\right\} \quad (3)$$

with a term containing K^2 omitted. For *calculating* an *equivalent to this* the temperatures at times A and G' in the figure are given. It is then a method which sufficiently combines accuracy and convenience to assume that the temperature, starting after an interval of L_H minutes from A, rose at a uniform rate for T minutes to the temperature $G'H$, and then remained constant at that temperature for $n-L$ minutes. That is, the temperature rise is simply multiplied by $\frac{1}{2}\,T + n - L$. Now the temperature at H actually is, in accordance with (2):

$$qT\left(1 - \frac{KT}{2}\right)\left(1 - K(n - L)\right) \quad (4)$$

Hence, using the approximation just suggested, the calculated thermal head is: $\phi''\, T' = qT\left(1 - \frac{KT}{2}\right)\left\{1 - K(n - L)\right\}\left(\frac{T}{2} + n - L\right)$, which is, again omitting terms containing K^2:

$$\phi''\, T' = qT\left\{\frac{T}{2}\ \frac{KT^2}{4} + (n - L) - KT(n - L) - K(n - L)^2\right\} \quad (5)$$

The difference between this and (3) is the error of the approximation made in calculating. It is:

$$\delta\,(\phi\, T') = qTK\left\{\frac{T^2}{12} + \frac{T(n - L)}{2} + \frac{(n - L)^2}{2}\right\} \quad (6)$$

The calculated thermal head is too small by this amount. A glance at (3) shows that this error is over half of the real change in $\phi T'$ due to the leakage.

With $T = 4$, $n - L = 1$, $K = 0.003$, this error causes a final error of 0.000,036 qT, which is safely negligible even in work of 0.1 per mille

accuracy, but can also be corrected for with ease. $n - L$ should usually be less than half a minute. With the large values of K characteristic of some aneroid calorimeters, closer approximations would be needed.

In using this method the value of L, the lag represented by BD in fig. 2, should be known rather accurately, since this affects directly the time assigned to the higher temperature, and so is in effect multiplied by $K\Delta\theta$ in getting the thermal leakage. Hence for 0.03 per mille precision, that is, for security in 0.1 per mille precision, L, if K is 0.003, should be known to 0.01 minute, like any other lag affecting the whole calorimeter. A very satisfactory way to determine it is this: Make a series of blank heatings, observing only thermal head or calorimeter temperature, as frequently as, say, every 15 seconds. Then, as in any regular calorimetric determination, find, from the calorimeter temperature, the total heat supplied, and also find the thermal leakage up to the time of each 15-second reading, which is not nearly so troublesome as it may sound. Then, knowing the total heat, the fact that it was supplied uniformly, and the thermal leakages, compute the calorimeter temperature corresponding to the heat actually in the calorimeter at each reading. Comparing these with the observed temperatures gives a series of values for the lag, whose average is comparatively unaffected by the fluctuations of the rapidly rising temperature, and of course has the thermal leakage eliminated. The same data give a check of correction (6) for the apparatus and conditions employed. The total leakage is usually so small that a predetermined value of K is quite good enough, hence no rating periods ("after periods") are needed. In a number of tests of this procedure the check of (6) was seldom out by more than 1/3 of (6) which, in this case, was about the uncertainty of a single reading, and corresponded to 0.25 second during the rapid rise of temperature. The main probable cause for the discrepancies observed was the fluctuation of the rising temperature as read. This seems to show that where the lag is constant, the method of calculation here given, corrected by means of (6), will probably give more accurate results in actual calibrations than observations of ϕ. Readings once a minute, however, though less accurate, will, with reasonably good stirring, be sufficient for observing the thermal head; this is why it can be observed along with the electric energy.

Such readings may be preferable or even necessary if the blank heatings have shown the lag to be variable.

Blank heatings will also enable an empirical expression, a substitute for (6), to be found in cases where the lag is large, and where, conse-

quently, the two triangular areas are not independent of each other, and (6) does not hold. Indeed, blank heatings alone might be used in most cases. The preceding analysis, however, seems generally useful in giving an idea of the sources of error, and of the precautions that must be taken if there is an initial thermal head, or if the jacket temperature changes, matters whose purely empirical investigation will generally be very tedious and of inferior accuracy.

Extension for Initial Thermal Head

An initial thermal head, that is, a difference between calorimeter and jacket at the time, A, will cause a thermal leakage which will be simply added to the one already considered, due to the heating. This leakage may properly be taken as modifying the initial thermal head which causes it, but as having no other effect. The two thermal heads, each with its resultant leakage, may therefore be considered as separate. The measurement made at the time of H in fig. 1, however, takes them together. If the simple approximation of (5) is then used the rise due to the heating, to which the approximation is applied, is underestimated, and no account is taken of the change in ϕ_o as such. Greater accuracy would therefore be obtained by adding again the fall in ϕ_o, multiplied by $\frac{T}{2} + n - L$, and subtracting the (integrated) real loss of thermal head due to the diminution of ϕ_o. The fall in ϕ_o is $\phi_o K(T+n)$, the loss of integrated thermal head from it is $\phi_o K \left(\frac{T+n}{2}\right)^2$; the application of the method of (5) is thus easily found to give a result which is too low by

$$\phi_o K \left(\frac{n}{2} - L\right)(n + T) \tag{7}$$

in addition to (6).

Change in jacket temperature can be similarly treated. If the jacket is electrically heated, so as to give a nearly adiabatic method, its lag, as usually in adiabatic work, will be as important as the lag in the calorimeter.

Initial Change in Heating

When the current is first turned into the heater the resulting change of temperature of the wire will generally cause an initial change of resistance and the value for the first few seconds will be different from

that measured. If the resistance for the first 10 seconds of 3 minutes differs by 1 per mille from the later, measured value, the discrepancy is appreciable in work of 0.1 per mille precision. Changes greater than this are possible, even in constantan wire, if the attempt is made to run at anything like the highest safe temperature. Although difficult to follow during a regular run, the change can easily be measured, and should be, by special experiments where nothing else is attempted, but subsequent variations in it will of course cause error. Unlike the lag effect already discussed, it has no tendency to cancel itself, since the reverse change in resistance comes only after the current has ceased to flow. To keep the heater coil running at a low temperature diminishes this error, and also that from loss of heat along the leads.

I, B. DEALING WITH UNSTEADY BATTERIES

Unsteady batteries are scarcely compatible with the very highest precision; with them the best results are obtained by some departure from standard procedure. (1) Very frequent, uninterrupted measurements of current or voltage tend to diminish the error from irregularly varying voltage, but demand either two observers with complete sets of apparatus, or else reliance upon the constancy of values for coil resistance, correlated with current and calorimeter temperature, determined by separate special experiments. (2) The voltameter, giving directly the product of current and time, handles perfectly the most sudden and irregular fluctuations[5] of current, and still leaves the observer's time free for other things. This time can be employed for measuring the coil resistance by a Wheatstone bridge, using the heating current itself as the bridge current.[6] This involves a loss of simplicity in the electric circuit, but is of advantage if it is desired to shunt part of the current by the heater, in order to give the voltameter the relatively large current which promotes accuracy with it; the Wheatstone bridge measurements can also be used as measurements of the shunt ratio. A further disadvantage is the relatively long time, 20 minutes at the very least, needed for high precision with the voltameter.

[5] There is evidently an error from very large fluctuations, owing to the fact that the heat is as the square of the current, but this error is usually quite negligible, and if not, can be avoided by a little coarse voltage regulation. The voltameter result is also sufficient when accompanied only by *accurate* measurements of voltage. In this case the voltameter makes the time measurement unnecessary, but does not deal well with voltage fluctuations.

[6] This has been done; the reference is not at hand. The coil resistance will vary very much less than the current, hence is far more easily measured when the current is unsteady.

II. ERRORS CONNECTED WITH THE LEADS

The proper place to put the potential terminals, whose location determines the amount of heat that comes into the measurement, is not at the ends of the constantan wire,[7] but outside the calorimeter altogether, at a point such that the heat generated in the lead wire between it and the calorimeter equals that flowing from the wire to the calorimeter. In general, the accurate location of this point is rather difficult, but it becomes easy if the heat given to the air can be neglected, since the proper point is then simply the middle of the free portion of the leads. The heat given to the air is easily found to be:

$$QX - \frac{Q}{\mu} \tanh \mu X \tag{8}$$

where Q is the heat generated in each centimeter of the wire, $2X$ is the length of each lead between surfaces, and the parameter $\mu = \sqrt{\frac{EP}{AK}}$, where E is emissivity, K thermal conductivity, A area, P perimeter. Langmuir's stationary surface layer rule has been used to get E.[8] Relatively crude data are here sufficient, since the attempt is only to determine when certain quantities are negligible, not to compute appreciable corrections.

One ampere at 110 volts generates 4733 calories in 3 minutes. In 1 cm. of No. 24 lead wire (about 0.5 mm. in diameter) it would generate 0.03626 calories, which number can conveniently be doubled, since we are dealing with a pair of leads, so the heat is 0.073 calories per cm. of lead length. For this wire, μ, calculated as in the paper just referred to, may be taken as 0.28, and 0.51 for No. 30 wire, while 0.16 was given for No. 18. We then have the values in table 1 for heat given to the air and not delivered at the ends, in 3 minutes.

It thus appears that, when the voltage across coil terminals is 110, and the current 1 ampere, with No. 30 leads 4 cm. long, No. 24 leads 10 cm. long, and No. 18 leads 28 cm. long, the heat lost to the air from the leads may be simply neglected. This is true even if the potential leads increase the loss to the air, which they will scarcely do if wound helically on the others and cemented there by shellacking. Moreover, the heat that goes into the air will in part return to the calo-

[7] Cf. H. C. Dickinson, Combustion calorimetry and the heats of combustion of . . . . Bull. Bur. Standards 11: 222, 1914.

[8] Cf. Walter P. White, The conditions of calorimetric precision. J. Am. Chem. Soc. 40, 1882, 1918.

rimeter, so the final loss is less than given in the table. On the other hand, the wire will not take the calorimeter temperature just at the surface, and the point of mean effective contact may be 1 or 2 cm. within. This will make the air loss as great as if part of the extra length were added to the wire in air, so it will be safer, in applying table 1, to take 2X as 2 cm. more than the free length of the wire.

TABLE 1.—APPROXIMATE LOSS TO THE AIR, IN CALORIES, IN 3 MINUTES FROM HALF OF 2 LEAD WIRES OF LENGTH 2X EACH.

	X, cm.	Diameter, mm.		
		1	0.5	0.25
1 ampere	1	0.00016	0.0018	0.023
	2	0.0012	0.014	0.14
	3	0.0039	0.04	0.35
	4	0.0086	0.08	
	5	0.016	0.13	
	10			
	14	0.14		
5 amperes	1			0.57
	2.5		0.62	
	6.5	0.75		
5 amperes	0.5			0.14
	1.5		0.15	
	3.5	0.148		

Of more importance may be the effect of the uncertain contact on the flow of the heat that does not go into the air. If the contacts are symmetrical no error results; if one is effectively 1 cm. deeper than the other, that is equivalent to a displacement of 0.5 cm. in the potential lead attachment. This, for 1 ampere, 110 volts, gives a systematic error of about 8 per million of the total heat with No. 24, and of only 30 per million even with No. 30 leads.

Thus with a little care even No. 30 wire will usually make satisfactory leads for a heater that can raise a liter calorimeter 5° in an appropriately short time. Coiled leads of larger wire are safer, but less convenient. Direct leads of larger wire increase various undesirable leakages unnecessarily.[9] If 5 amperes is used the heat produced in the wires is 25 times as great, but at 110 volts the allowable leakage

[9] For a precaution necessary with No. 18, or even with No. 24 leads see Walter P. White, op. cit., p. 1884.

is 5 times as great; not so if the 5 amperes is used to give the same heat, at lower voltage. The limits of toleration of air loss for each case are shown in the second and third sections of table 1. For a given size of wire the proportional error is constant for a given coil resistance, regardless of current or voltage. The error from lack of symmetry in the thermal contacts at the two ends of the free portion of the leads may also become serious. For 1 cm. difference, 5 amperes and 110 volts, this error is nearly 40 per million for No. 24 wire, which therefore seems the very smallest that should be used for 100 per million precision with coils of as low resistance, 22 ohms, as is required for this current and voltage. Another advantage in using slender leads is that they can be removed from the calorimeter with but little change in the total heat capacity. This is assuming that the heater itself remains, so that any uncertainty there may be as to its heat capacity does not affect the application of the result of the calibration.

The conductivity of the potential leads may disturb the symmetrical distribution of the heat generated in the current leads. This can be avoided by making the potential leads symmetrical with respect to calorimeter and jacket, as by having one lead run from the neutral point into the calorimeter, there turning around (still insulated electrically) to run entirely across the gap and out through the jacket.

Thus far the upper part of the heater case and the leads within it have been taken as at the calorimeter temperature, except for a slight correction due to the effect of heat coming in from the free part of the leads. If the upper part of the case or the leads are heated above the calorimeter temperature by the heating coil itself, the only way of avoiding an uncertain correction appears to be to run the leads a sufficient distance in close contact with some conducting body which, by immersion in the water or attachment to the calorimeter wall, or in some other way, is kept at the calorimeter temperature. If only the leads are heated and not the top of the case, it may be sufficient merely to have the leads run a considerable distance before leaving the case.

The required distances can be calculated by the formulas of the section on Conduction through the Jacket, in the paper already referred to. For example, the following results were thus obtained for No. 24 wire, running 5 cm. in the case and 6 cm. through the air to the jacket. For this wire μ in air has been taken as 0.28. For the wire in close thermal contact with a plate on one side only, as it would be if wound around a central mica strip in a flat case, μ can be taken as 0.040 Then if θ_0 is the temperature of the inner end, next the heater coil, of the 5 cm. of wire, referred to the calorimeter-air-jacket temperature as

zero, the temperature where the wire enters the air is 0.18 θ_o, and the heat carried away by 2 leads in 3 minutes is 0.037 θ_o calories. For 110 volts and 1 ampere the systematic error of such an arrangement with the heating coil running at 120° would be about 1 per mille, and the coil must heat less than 3° to safely avoid systematic error in work of 0.1 per mille precision. By doubling the length of lead in the inclosure the permissible heating is increased, somewhere near 8 times. A doubling of μ would have an identical effect, but would be rather hard to secure with the same size of wire. It therefore seems that it would generally be very desirable to insert portions of finer lead wire next the coil, using enough larger wire further out, but well within the calorimeter, to dissipate to the calorimeter the heat generated in the fine wire. Advantageous dimensions can be calculated from the data already given. The insertion of too much copper resistance gives the heater resistance too great a temperature coefficient. There is little danger of trouble from this cause, however, as long as its possibility is not overlooked.

The assumption of temperature equality between calorimeter and jacket, used in this section, is justified as follows: The temperature distributions and flows existing at any time are the resultant of the electric heat and of the jacket-calorimeter difference, and may be resolved into components due to these different sources. Since by a well known principle the resultants of such components can be obtained by simple addition, and since the results of the calorimeter-jacket difference are taken care of in the regular procedure, we may treat the electric effects alone, as if the others were non-existent.

BOTANY.—*The genus* Microstaphyla.[1] WILLIAM R. MAXON, National Museum.

Among the many diverse ferns comprising the tribe Acrosticheae of the family Polypodiaceae one of the most interesting of all is the diminutive plant of St. Helena first described by the younger Linnaeus in 1781 as *Adiantum furcatum*, and later by Jacquin as *Osmunda bifurcata*. By the older writers it was placed at one time or another in no less than seven different genera, before serving as the type and sole species of *Microstaphyla* Presl. This, like so many other of Presl's genera, was submerged in synonymy by later writers. In 1895 a closely related Bolivian plant, with simple instead of pinnate sporo-

[1] Published by permission of the Secretary of the Smithsonian Institution. Received November 29, 1922.

phylls, was described by Mrs. Elizabeth G. Britton as *Acrostichum moorei*. Since then the systematic status of *Microstaphyla* and the nomenclature of the Bolivian plant have received a good deal of attention at the hands of Underwood[2] and Christ.[3] Christ comes to the conclusion that, notwithstanding the close general agreement in dissected foliage leaves shown by the St. Helena and Bolivia species, the slender scaly rhizome and simple sporophylls of the latter plant form a definite connecting-link between *Microstaphyla* (in its original sense) and *Elaphoglossum*. The characters of *Rhipidopteris* and of certain small Andean species of *Elaphoglossum* are discussed in this connection, and both *Microstaphyla* and *Rhipidopteris* are reduced to the rank of subgenera under *Elaphoglossum*—the former to include the two species with pinnate sterile fronds, the latter those with palmately or flabellately divided sterile fronds. Nevertheless, both Hieronymus and Underwood have regarded *Microstaphyla* and *Rhipidopteris* as valid genera, and in this opinion the writer is obliged to concur. Christ's arguments lose none of their weight from the evolutionary standpoint; the question is merely upon the rank to be assigned to the forms as they exist today. In their peculiarly distinctive sterile fronds both *Rhipidopteris* and *Microstaphyla* depart too widely from simple-leaved *Elaphoglossum* to be retained in that genus.

Very recently a third species of *Microstaphyla* has been discovered in Colombia. This is described below. There is given also the principal synonymy of the two species previously known.

1. **Microstaphyla furcata** (L. f.) Fée, Mém. Foug. **7**: 45. *pl. 13*. 1857.
   Adiantum furcatum L. f. Suppl. Pl. 447. 1781.
   Osmunda bifurcata Jacq. Coll. Bot. **3**: 282. *pl. 20, f. 2*. 1789.
   Acrostichum bifurcatum Swartz, Journ. Bot. Schrad. **1800**[2]: 13. 1801. Not *A. bifurcatum* Cav. 1799.
   Gymnogramma bifurcata Kaulf. Wes. Farrnkr. 81. 1827.
   Darea furcans Bory, Dup. Voy. Bot. **1**: 269. *pl. 35, f. 2*. 1828.
   Olfersia bifurcata Presl, Tent. Pter. 234. 1836.
   Polybotrya bifurcata J. Sm. Journ. Bot. Hook. **4**: 150. 1841.
   Microstaphyla bifurcata Presl, Epim. Bot. 161. 1851.

Known only from St. Helena, where it has been repeatedly collected. Of the two specimens at hand, one is no. 420 of Cuming's historic collection; the other bears no collector's name.

The present species is too well known to require detailed discussion. Besides the illustrations above given, those of Schkuhr and Hooker may be

[2] Torreya **5**: 87–89. 1905.

[3] Bull. Herb. Boiss. II. **1**: 588–592. *text fig.* 1901; ibid. II. **3**: 148. 1903: Torreya **5**: 123–126. 1905.

cited.[4] Hooker's comments on Fée's error in associating with it the plant now called *Elaphoglossum dimorphum* (Hook. & Grev.) Moore are of interest.

2. **Microstaphyla moorei** (E. G. Britton) Underw. Torreya 5: 88. 1905.
Acrostichum moorei E. G. Britton, Mem. Torrey Club 4: 273. 1895.
Rhipidopteris rusbyi Christ, Farnkr. Erde 46. 1897.
Elaphoglossum bangii Christ, Mon. Elaph. 99. 1899.
Elaphoglossum moorei Christ, Bull. Herb. Boiss. II. 3: 148. 1903.
Microstaphyla bangii Hieron. Bot. Jahrb. Engler 34: 539. 1904.

Founded on specimens collected near Yungas, Bolivia, in 1890, by Miguel Bang (no. 558), of which two sheets are at hand. The specific name is in honor of Thomas Moore, whose fern collection in the Kew Herbarium is said to contain a specimen collected by Lechler "near Sachapata, on trunks of trees, and distributed as no. 2609, Plantae Peruvianae." Hieronymus also lists *Lechler* 2609 under this species, probably with correctness. An additional specimen has recently been received from Bolivia: On tree-trunks, among moss, Hacienda Simaco, on the trail to Tipuani, altitude 1,400 meters, January, 1920, *Buchtien* 5297; this agrees very closely with the Bang material.

It is to be noted that Hieronymus cites also a Colombian specimen, collected in 1882 by Schmidtchen, the exact locality not stated. This, which has not been seen by the writer, not improbably pertains to the next species.

3. **Microstaphyla columbiana** Maxon, sp. nov.

Plants terrestrial, entangled in a loose mat. Rhizomes wide-creeping, 30 cm. long or more, about 0.5 mm. in diameter, flexuous, sparingly branched, bearing a few distant roots, brownish, sulcate, flattish or irregularly triquetrous in drying, subpersistently paleaceous, the scales loosely appressed-imbricate, pale yellowish brown, membranous, translucent, 2 to 2.5 mm. long, narrowly deltoid-ovate, attenuate, attached above the closed sinus of the very deeply cordate base (the lobes widely overlapping), with a few, mostly basal teeth. Sterile fronds numerous, borne singly 1 to 5 cm. apart, ascending, 8 to 18 cm. long; stipes continuous with the rhizome, 3 to 7 cm. long, about 0.5 mm. thick, brownish and terete at the extreme base, upward greenish and compressed, slightly alate at summit, deciduously paleaceous throughout, the scales ovate-oblong, acute, often coarsely dentate; blades lanceolate, caudate, 5 to 11 cm. long, 2 to 3 cm. broad just above the base, essentially pinnate at base, nearly so throughout; pinnae 5 to 10 pairs, oblique, subopposite at base, mostly alternate above, distant (5 to 10 mm. apart on each side), linear-cuneiform, 1 to 3 mm. broad just above the narrowly decurrent base, dichotomously forked at or beyond the middle (the divisions 2 to 8 mm. long, the distal one usually the longer, one or both deeply retuse), or those toward the apex linear-subspatulate, merely retuse, the apical ones gradually reduced, finally evident as coarse distant serrations of the long-caudate tip; veins mostly arising in pairs at base of pinnae, once or twice forked, 4 branches usually occurring at middle of pinna, 2 extending to each division, clavate; leaf tissue glabrous, dull green, membrano-herbaceous, opaque, the venation seen with difficulty. Fertile fronds wanting.

[4] Krypt. Gew. *pl. 2;* Second Cent. Ferns, *pl. 91.*

Type in the U. S. National Herbarium, no. 1,140,001, collected in dense forest above La Cumbre, Department of El Valle, western cordillera of Colombia, at about 2,200 meters altitude, September 18, 1922, by Ellsworth P. Killip (no. 11365). The description is drawn partly from a second sheet of the type collection. Duplicates will be distributed to the Gray Herbarium, the New York Botanical Garden, and the Academy of Natural Sciences, Philadelphia, in whose interests also the recent botanical exploration in western Colombia was conducted under the leadership of Dr. F. W. Pennell.

Related to *Microstaphyla moorei*, which is distinguished readily, however, by (1) its oblong, non-caudate blades, the basal pinnae not reduced and the apical ones few and abruptly discontinuous; (2) its very much narrower divisions, these acute and invariably with a single veinlet; (3) its delicately membranous, translucent leaf tissue, the venation being readily evident without the aid of transmitted light. *M. moorei* is a more delicate plant than *M. columbiana* in every way; in some fronds all the pinnae are undivided. Fertile fronds of *M. columbiana*, unrepresented in the material at hand, are presumably similar in general form to those of *M. moorei*.

SCIENTIFIC NOTES AND NEWS

A recent circular to employees of the U. S. Coast and Geodetic Survey calls attention to tests made in the section of field records which indicate that mounted drawing paper in rolls fails to give flat surfaces when cut into lengths for immediate use. Due to unequal seasoning, surplus paper exists near the lengthwise edges of the rolls and this condition brings about a noticeable distortion in projections constructed on the sheets. In order to minimize this unequal seasoning it is suggested that entire rolls of mounted drawing paper, when received in the field, be immediately cut into sheets of suitable lengths for smooth plotting work and stowed face down in a ventilated drawer.

Final tests of the new field automatic tide gauge of the U. S. Coast and Geodetic Survey were made recently at the Lighthouse Wharf in Washington. These tests showed that this tide gauge will give thoroughly satisfactory records for use of hydrographic parties.

The Carnegie Institution of Washington will continue to cooperate in the seismologic work and investigation of crustal movement in California. Special attention will be paid to the development of new instruments for the measurement of small earth tremors. An interesting feature of the recent exhibit at the Institution was a map showing the location of faults in California. The production of this map was made possible by the cooperation of scientific and mercantile interests. It will be published in final form by the Seismological Society of America.

Two destroyers of the U. S. Navy are engaged in making sounding measurements off the west coast of the United States with the "sonic" sounding apparatus. Parallel runs are being made at distances of five or ten miles and soundings are taken up to the two thousand fathom mark. The object is a complete topographic map of that part of the bottom of the sea.

The Petrologists' Club met on Tuesday, December 19, at 8 p.m. Dr. N. L. Bowen spoke on *The action of magmas on autolithic and xenolithic material.* He reviewed the various possible directions of crystallization and subsequent reaction between liquid and solid phases, and thus accounted for the various series of igneous rocks which are found in many localities.

Among those on the program of the thirty-fifth annual meeting of the Geological Society of America at Ann Arbor, Michigan, December 28–30, 1922, were the following members from Washington: M. Aurousseau, N. L. Bowen, William Bowie, Arthur Keith, Willis T. Lee, and Fred E. Wright.

At the twenty-fourth annual meeting of the American Physical Society at Boston, December 27–29, 1922, papers were given by the following representatives of Washington institutions: L. A. Bauer, P. D. Foote, F. L. Mohler, W. J. Peters, and Frank Wenner.

Mr. M. G. Donk, for the last two years connected with the Edgewood Arsenal, Chemical Warfare Service, has joined the staff of the chemical division of the U. S. Tariff Commission. He will specialize in heavy chemicals.

Mr. Charles W. Hoy of the Smithsonian Institution left Washington December 15 for a two years' trip in Central China, in the basin and mountains of the Yang-tse, devoting most of his time to collecting mammals, birds, and fishes.

Representative R. Walton Moore was appointed a regent of the Smithsonian Institution December 7.

Dr. Bailey Willis, emeritus professor of geology, Stanford University, sailed for Chile January 11 to investigate the evidence of the recent earthquake, in response to an invitation sent to the Carnegie Institution of Washington through the Chilean Embassy.

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ETHNOLOGY.—*New light on the early history of the Siouan peoples.*[1]

John R. Swanton, Smithsonian Institution.

Relationship between several of the languages of the western Siouan group was recognized by French missionaries about the beginning of the eighteenth century. In 1836 Gallatin brought most of the tribes of this division together under the name afterwards adopted by Powell in his well-known scientific classification.[2]

In the year 1870 Dr. Horatio Hale had obtained from a few surviving members of the Tutelo tribe incorporated with the Iroquois a vocabulary demonstrating beyond question the Siouan connection of this former Virginian people, and the results of his work were published in the *Proceedings of the American Philosophical Society* for 1883–4, pp. 1-47. Dr A. S. Gatschet of the Bureau of American Ethnology visited the Catawba tribe of South Carolina in 1881 and on the basis of a considerable body of linguistic material then collected suggested a Siouan relationship for them, a suggestion which subsequent researches by Dr. J. O. Dorsey, the Siouan specialist of the Bureau, entirely confirmed.[3] With these two languages as a basis further investigations by the same students and by Mr. James Mooney resulted in the identification of a large eastern Siouan area in the piedmont region of Virginia and the Carolinas, including at the time of the English colonization about thirty distinct tribes. The results of this work were incorporated by Mr. Mooney into a bulletin entitled "The Siouan Tribes of the East" which remains a standard authority on the subject today.[4]

[1] Received January 3, 1923.

[2] 7th Ann. Rep. Bur. Amer. Ethnol., 111–112.

[3] Ibidem.

[4] Bur. Amer. Ethnol. Bull. 22.

In the fall of 1886 Dr. Gatschet, in the course of linguistic researches among the tribal remnants of Louisiana, came upon a few individuals of the Biloxi tribe, formerly occupying the neighborhood of the bay of that name in southern Mississippi. The vocabulary collected by him showed undoubted Siouan affinities, and in 1892 and 1893 Dr. Dorsey made visits to the same people and collected a large amount of material from them which was edited by the writer after Dr. Dorsey's death and published in Bulletin 47.[5]

In 1908, among the remnant of Tunica Indians living near Marksville, Louisiana, the writer happened to meet with a single individual of the Ofo, or Ofogoula, tribe, previously supposed to have been Muskhogean, and the vocabulary collected by him, although relatively small, proves without doubt that this little tribe was also of the great Siouan connection. More detailed information regarding both the Ofo and the Biloxi will be found in the Bulletin just mentioned.[6]

A superficial comparison between the Biloxi and Ofo languages on one hand and the remaining Siouan dialects on the other, made when the material from the first two was being prepared for publication, brought out the rather surprising fact that, intead of resembling the Siouan language nearest them, Quapaw, they were connected rather with the Tutelo of Virginia and the Dakota of the far north. At this time it was assumed that since Tutelo and Catawba were both dialects of the eastern Siouan group they must be more closely related to each other than was either to any language of another group and that what was true of Tutelo must necessarily be true of Catawba. A few years later, however, the writer paid a visit to the Catawba remnant in South Carolina and in connection with his visit the material collected by Dr. Gatschet about forty years ago was reëxamined. Almost immediately a striking difference was perceived, not merely as between Catawba and Tutelo but as between Catawba and all other Siouan languages. The same conclusion has been reached by another investigator in the same field, Dr. Frank G. Speck, who also feels certain that the differences had a cultural aspect. Catawba is evidently a survival of a peculiar southeastern Siouan group which took in all of the Siouan tribes of South Carolina and probably most of those of North Carolina as well.

In order to place the relationship between these languages on a firm basis the writer has taken Hale's comparative vocabulary of Tutelo, Dakota, and Hidatsa as a basis and added to it the Biloxi, Ofo,

[5] Bur. Amer. Ethnol. Bull. 47.

[6] Ibidem, pp. 5–12.

Catawba, Winnebago, and Quapaw equivalents, so far as this could be done without a too great expenditure of time. He has also included the few words of Woccon preserved to us in the vocabulary of Lawson.[7] This comparison leads to the following conclusions:

1. Woccon must be classed with Catawba rather than Tutelo. Of about fifty-nine opportunities to compare Woccon with the other languages resemblances to Catawba appeared to exist in about twenty-six cases, while there were fourteen with Tutelo, Biloxi, and Hidatsa, fifteen with Dakota, and twelve with Ofo.

2. Leaving Woccon out of consideration, Catawba stands strikingly apart from the rest. In order to reënforce this fact I have made a table (p. 36) containing more than forty cases in which all or a large part of the Siouan dialects compared agree with each other and differ, sometimes strikingly, from Catawba.

3. As might have been anticipated, Biloxi and Ofo are quite closely related. Their nearest congeners in the north are, upon the whole, the Tutelo, but it is singular that their next closest relatives should be the comparatively distant Dakota. The Omaha-Osage division is decidedly farther removed. The testimony yielded by the languages of the Biloxi and Ofo thus points directly away from those Siouan tribes nearest them in geographical position both east and west and toward the northern tribes of each of those divisions.

How this puzzling inversion could have been brought about it was impossible to suggest until recently, and the past history of the Biloxi is, indeed, still shrouded in mystery. On the map of Baron de Crenay compiled in 1733 we find the name "Bilouchy" affixed to a town at the mouth of a small creek on the western side of Alabama River, in what is now Wilcox County, Alabama.[8] This may indicate a stage in the southward migration of the Biloxi tribe; it is the only clew we have.

Our knowledge of the past movements of the second southern Siouan tribe, the Ofo, is not much more assured, but recently data has accumulated tending toward a conclusion interesting in itself to the ethnologist and of cardinal importance to students of the archaeology of southern Ohio and the neighboring sections.

As stated in my account of the Ofo in Bulletin 47 this tribe is called by the Tunica Ûcpi (Ûshpee),[9] and we know that this appellation is an old one because it appears four times in the very earliest Louisiana documents, in the several forms "Ouispe," "Oussipés," "Ounspik"

[7] Lawson, Hist. of Carol., 367–377.

[8] See map accompanying Bur. Amer. Ethnol. Bull. 73.

[9] Bur. Amer. Ethnol. Bull. 47: 10–11.

TABLE TO ILLUSTRATE THE

ENGLISH	CATAWBA	BILOX.	OFO	TUTELO
alive, live	wari	unoxŏ	nônki	inī
all	nitem(p)	ohi	tcupi	hūk
ax	pase‘	a^{n}sēpi	a^{n}fhepi	nisēp
ball	wap	nitapi	(plocka)	tapi
bear	nume	o^{n}ṭi	u^{n}thi	mūnti
black	hawōktci	sàpi	ifthĕpi	asēpi
blue	wu, wi	tohi	ithohi	asōti
bone	sap	aho	aho	wahōi
dance, to	ibari	ditci	litci	wagitci
day	yap	napi	no^{n}pi	nahambe
dead, die	ware	ṭe	thŏ	tē
dog	ta^{n}si	tcûñki	atchuñki	tcoñki
ear	duksa	nixuxwi	nashusi	naxōx
eat, to	hara, ra	duti	tuti	lūti
father	nane	adi	athi	eāti
fire	i^{m}pi^{e}	peti	apheti	pīte
fish	yī	o	ho	wihōi
foot	yipa	isi (yukpe, leg)	ĭfhi	ici
four	paprere	topa	topa	tōpa
ghost	yī^{n}we	anatci	na^{n}tci	wanuntcī
good	kuni, kuri	pi	tcema	pī
grandfather	tatewa	ka^{n}xo	ĕtiko^{n}so	eku^{n}i
grandmother	istcū	ḳû^{n}ḳû^{n}	ĭkoni	higū^{n}
great	patki	ta^{n}	itho^{n}	itá^{n}i
hair	hisi	hi^{n}	ihi	nató^{n}we
hand	iksa	tcak	itcaki	hāki
he	o	e, i	i	e, i
head	iska	pa	. . . . . .	pasūye
house	sūk	ti	àthi	atī
I, me	sa-, ne-	ñk-	ba	ma
iron	dorob	masà	amô^{n}fi	ma^{n}s
kill, to	gua	kte (to hit)	kthŏ	ktō
mother	istci	û^{n}ni	o^{n}ni	īna
mouth	sumu	ihi	ihi	ihī
neck	pok	dodi	itcoti	tasōi
one	nĕpĕ	so^{n}sa	nûfha	no^{n}ç
pound, to	himi^{e}	pĕhe	pho	pahē
rain	ukso	xohi	ashohi	xawōi
sister (man's)	hatcu	tañḳi	itho^{n}fka	tahañk
sit, to	wa^{n}	nañḳi	nôñki	(maha) nañka
six	dipkrare	akàxpŏ	akápĕ	akāsp
tobacco	umpa	yani	itcani	yōhni
tooth	yap	i^{n}su	ifha	ihī
town	wē	ta^{n}	i^{n}tufa	māmpī
tree	yàp	aya^{n}	itca^{n}	onī, wiō^{n}
us, we	hâ	nḳixtu	o^{n}	mae, wae
water	yēhiĕ	ani	ani	manī
yellow	wuyantkare	si	fhi	sīi

Distinctiveness of the Catawba Dialect

DAKOTA	HIDATSA	WINNEBAGO	QUAPAW
ni	hiwakatsa	ni	ni
iyuxpa	xukaheta	ana^{n}tc	zani; anahitĕ, juhi (many)
o^{n}spe	maipsa	maza	i^{n}spe
tapa	māotâpi	......	......
mato	daxpitsi	ho^{n}tc; ma^{n}tco (grizzly)	wasa (blk.); ma^{n}tu (grizzly)
sapa	cipi	sĕp	cape; sa, sewe
to; sota	tohi	tco	tu
hu	hidu	hucerigera, hucarek	wahi
watci	kidiçi	waci	uja
a^{n}pé	mape	ha^{n}ba	hă^{n}ba, hû^{n}ba
ta	te	ṭ'e	ṭ'e
cunka	macuka	cûñga	cuñkĕ
noghe	akux	natca	na^{n}tă
yuta	duti	warutc-	d¢atĕ
ate	ate	hia^{n}tci	ed¢ate (his f.)
peta	......	petca	petĕ
hogha^n	mua	ho	hu
siha	itsi	si, si	si
topa	topa	tcop	tuwa
wanaghi	nokidaxi	wanaxi	wanaxe
wacte; pi	tsūki	pi	huta^n, uxta
tuñka^{n}cida^n	adutaka	hitcoke	etiḳă^n
ku^{n}sitku	iku	hiko	eḳă^n
tañka	ixtia	xete, xata	tañḳa
hi^n	hi	natcu	hi^n; nijiha (kĕ) (head hair)
cake (claw)	caki	naba	na^{n}pe
iye	i	e	e
pa	atu	nasu; pa-(ksi) (head bent)	pahi
tipi	ati	tcija^n	ti
wa, ma	ma	ne	wie (I)
maza	uetsa	maza-ra	mâ'zĕ
kte	kitahe	......	......
ina	hidu	hiû^{n}ni (his mother)	ehû^n, eha^n
i	i	i-da	iha
dote	ampa	tcaceda, tcacera	taită; tutĕ (throat)
wa^{n}ji	nuetsa	-cana	mi^n, mi^{n}xti
apa	pa	...... (in composition)	pĕ
maghaju	xade	niju	niji
tañka	itaku	wai-tcke	etuñke (his sister)
iyotañka	amaki	năñka	kni^n; nika, niñka (or std.)
çakpe	akama	......	capĕ
tca^{n}di	ope	dani	tani
hi	hi	hida, hira	hi
oto^{n}we	ati	tci-nañka	ta^{n}wa^n; tû^n (abbr.)
tca^n	mina	na^n	jă^n, jû^n
u^n	mido	......	uñkuwe
mini	mini	ni	ni
zi	tsi	zi	zi

(evidently misprinted), and "Onspée." It need occasion no surprise that the term appears alongside of the more common name Ofogoula in three of these cases. "Ofogoula," whether it was or was not derived from the term current within the tribe, was the one which had been adopted into Mobilian, the trade language of the lower Mississippi. The fourth is from the Jesuit Father Gravier who got all of his information from Father Davion at the Tunica mission or else from Tunica Indians directly. It is only natural that they should have employed merely the term current among themselves. Later, when the French came to know these Indians better, the foreign designation disappears, naturally enough, and only the name Ofogoula remains.

This latter form certainly contains the Choctaw and Mobilian ending okla, people, and since ofe means "dog" in the same languages it was natural that Du Pratz should translate the whole "dog people." In Bulletin 47 I expressed the opinion that this was due to a confusion of the native name of the tribe, Ofo, with the Mobilian word ofe.[10] It is, however, possible that the Mobilian designation had been completely taken over by the people to whom it was applied. At any rate there are other evidences that the Ofo were at times actually called "Dog People." Thus in an account of the route from the Illinois by the Mississippi River to the Gulf of Mexico by Tonti, written between 1685 and 1690, he speaks of "The Ionica (Tunica), Yazou, Coroa, and Chonque . . . . on the river of the Yazou" scattered along its lower course.[11] The Ofo is the only known tribe to which the word Chonque might apply and it closely resembles the common Siouan term for "dog." In Ofo this would be atchuñki (achunke), but Tonti had Quapaw interpreters with him at times and in Quapaw it would be cuñkĕ (shunke). The name appears once more in the *Carolana* of Daniel Coxe, who says: "Ten leagues higher [on the Mississippi above the mouth of a river called "Matchicebe" upon which dwelt the Mitchigamia], on the east side, is the river and nation of Chongue, with some others to the east of them."[12] It is also laid down upon his map. In this latter case there is nothing to identify the tribe mentioned with the Ofo except the resemblance between the name applied to them and that used by Tonti, and our inability to identify them with any other people.

The map and text of Coxe present us, however, with another possibility which seems at one and the same time to throw more light on

[10] Bur. Amer. Ethnol. Bull. 47: 10.

[11] French, Hist. Coll. La.: 82. 1846.

[12] Coxe, Carolana, 12, 1741, and map.

the subject and to add to its confusion. This is connected with a people called by Coxe "Ouesperies," the similarity of whose name with the Tunica name for the Ofo was first suggested by Mr. W. E. Myer. After describing the Quapaw villages at the mouth of the Arkansas River Coxe says: "Ten leagues higher is a small river named Cappa, and upon it a people of the same name, and another called Ouesperies, who fled to avoid the persecution of the Irocois, from a river which still bears their name, to be mentioned hereafter."[13] The river "Cappa" was perhaps the St. Francis but an exact identification of it is here unnecessary. The river whence this tribe had come seems to have been the Cumberland or a branch of the same, judging from Coxe's description: "South of the Hohio is another river, which about thirty leagues above the lake is divided into two branches; the northerly is called Ouespere, and the southerly the Black River; there are very few people upon either, they having been destroyed or driven away by the aforementioned Irocois."[14] The Tennessee is described immediately afterward. If Mr. Myer's suggestion is correct, we must then assume a northern origin for the Ofo and a relatively recent southward migration on their part.

Early literature contains no further mention of this tribe under the form of the name which Coxe uses, but we know of a tribe in the region which had a strikingly similar history and whose identity is shrouded in equal mystery.

This first appears on Franquelin's map of 1684 in what is now southern Ohio in the form "Mosapelea" under which is added "8 Vil. detruits." The destruction of these villages must have taken place at least five years earlier since the tribe is placed on the eastern bank of the Ohio on Marquette's map, and, as Hanna has shown, it was evidently the unnamed tribe visited by Marquette and his party and described as having had communication with Europeans and being provided with firearms.[15] This is what the missionary has to say of the tribe:

"While thus borne on at the will of the current, we perceived on the shore Indians armed with guns, with which they awaited us. I first presented my feathered calumet, while my comrades stood to arms, ready to fire on the first volley of the Indians. I hailed them in Huron, but they answered me by a word, which seemed to us a declaration of war. They were, however, as much frightened as ourselves, and what we took for a signal of war, was an invitation to come near, that they might give us food; we accordingly

[13] Ibidem, 11.
[14] Ibidem, 13.
[15] Hanna, The Wilderness Trail, II: 99–100.

landed and entered their cabins, where they presented us wild-beef and bear's oil, with white plums, which are excellent. They have guns, axes, hoes, knives, beads, and double glass bottles in which they keep the powder. They wear their hair long and mark their bodies in the Iroquois fashion; the head-dress and clothing of their women were like those of the Huron squaws.

"They assured us that it was not more than ten days' journey to the sea; that they bought stuffs and other articles of Europeans on the eastern side; that these Europeans had rosaries and pictures; that they played on instruments; that some were like me, who received them well. I did not, however, see any one who seemed to have received any instruction in the faith; such as I could, I gave them with some medals."[16]

From the Huron resemblances noted by Marquette Shea suggests an Iroquoian relationship for this people but nothing certain can be deduced from his words and the old home of the Monsopelea was not far from the Erie and other Iroquoian peoples from whom the customs noted might have been derived. Lower down Marquette was informed by the Quapaw "that the Indians with fire-arms whom we had met, were their enemies who cut off their passage to the sea, and prevented their making acquaintance of the Europeans, or having any commerce with them; that, besides, we should expose ourselves greatly by passing on, in consequence of the continual war-parties that their enemies sent out on the river; since being armed and used to war, we could not, without evident danger, advance on that river which they constantly occupy."[17] It is probable that the explorers confounded what was said about this particular enemy tribe which they had met with accounts of other enemy tribes, and either Marquette or those who read his narrative not unnaturally assumed that the fire-arms and other European goods were brought from the mouth of the Mississippi. They therefore supposed that there must be another settlement of the same enemies below them and so it is represented on the maps of Thevenot and Joliet. Thevenot also gives "Aganahali" as the name of a tribe associated with the Monsopelea. As there was no European settlement nearer the mouth of the Mississippi than the Apalachee country of Western Florida and the Spaniards were not allowed to furnish the Indians with fire-arms, it must be supposed that they had obtained their weapons either from the English in Virginia or the Dutch of New Netherlands.

Under this name, or this form of the name, the tribe appears but once afterward. When La Salle stopped at the Taensa village on what is now called Lake St. Joseph, Louisiana, Tonti says:

[16] Shea, Discovery and exploration of the Mississippi Valley, 43–44.

[17] Ibidem, 47–48.

"The next day a chief of the Mosopellea, who after the defeat of his village has asked the chief of the Tahensa for permission to dwell with him, and dwelt there with five cabins, went to see M. de la Salle, and having said that he was a Mosopellea, M. de la Salle restored to him a slave of his nation, and gave him a pistol."[18]

From this time on the tribe of the Monsopelea, unless disguised under some other name, disappears from history as absolutely as if the earth had opened and swallowed it up. My belief is that neither did the earth open for its accommodation nor did later explorers manage to pass it by without notice, but that, after having moved from one place to another, it finally drifted to the lower Yazoo to reappear in the records of French Louisiana under the name of Ofogoula.

This view is supported by the following facts:

1. The name Ofogoula does not make its appearance until after that of Monsopelea disappears, and where Tonti employs the word Chonque he does not use any synonymous term known to have been applied to the Ofogoula. With the exception of the use of Ouispe alongside of Ofogoula by three early authorities, a circumstance already explained, the names which I have supposed to be intended for the Ofo are introduced simultaneously only in the work and on the map of Coxe. Coxe enters on his map the Monsopelea, Ouesperie, and Chongue and he speaks of the two last in his text. However, by his own statement his data were collected from many sources and the same tribe may hence have been entered under different names especially if, as was the case with the Ofo, it was frequently changing its location. So far as the name Monsopelea is concerned there is reason to think that Coxe obtained his information from French sources, and at all events he places it erroneously above the mouth of the Ohio instead of below it. It should be added that only one of the names of the seven tribes which he locates upon Yazoo River might possibly refer to the tribe under discussion, the rest being otherwise identified, and this one must almost certainly be excluded also.

2. The history of the Ouesperie of Coxe and the Monsopelea of the French is very similar. Both once lived on or near the Ohio; both were driven away, in the one case by the Iroquois, in the other presumably by the same people; and both fled in the same direction and disappear from history in the same general region.

3. All of the names given to this tribe may be explained as synonyms of two which are known to have been employed for the Ofo. The

[18] Margy, Dec., I: 610.

relationship of "Ofo," "Ofogoula," and "Chongue" has already been explained, and the following table will help us to understand the possible connection between the remainder:

Authority										
Marquette....................	M	o	n	s	8	p	e	l	e	a
Thevenot.....................	M	o	n	s	ou	p	e	l	e	a
Allouez......................	M	o	n	s	o	p	e	l	e	a
La Salle.....................	M	o		s	o	p	o	l	e	a
Tonti........................	M	o		s	o	p	e	ll	e	a
Hennepin.....................	M	a	n	s	o	p	e	l	e	a
Douay........................	M	a	n	s	o	p	e	l		a
Franquelin...................	M	o		s	a	p	e	l	e	a
Marquette....................	M	o	n	s	ou	p	e	r	e	a
Coxe.........................		Oue		s		p	e	r	ie	
Coxe.........................		Oue		s		p	e	r	e	
Gravier......................		Ou	n	s		p	ik[ie?]			
La Harpe.....................		O	n	s		p	ée			
Pénicaut.....................		Ou		ss	i	p	é			
Iberville....................		Oui		s		p	e			
Swanton (1908)...............		Ŭ		sh		p	ĭ			

Virginia documentary history shows that a Siouan tribe called Moniton ("Big Water People") were living on or near the Kanawha River, West Virginia, as late as the latter half of the seventeenth century.[19] If my hypothesis, as above outlined, is correct there was also, down to the historic period, a Siouan tribe just beyond them in southern Ohio. At the same time it was well-known among the Indians along the middle course of the Mississippi that the Arkansas tribe, known to us in later times as Quapaw, had formerly dwelt on that part of the Ohio above its junction with the Wabash. Besides the published statements to that effect[20] may be cited the following excerpt from an unpublished French document, a copy of which is in the Manuscripts Division of the Library of Congress. The writer of this document enumerates five rivers falling into the Wabash, by which he means our present Wabash *and* that part of the Ohio between the junction of the two streams and the Mississippi, and he calls the third of these, now known as part of the Ohio proper, "Rivière des Accansa qui autres fois y demeuroient et ont abandonné leur village." The intimate linguistic relationship of the Osage, Kansa, Omaha, and Ponka with this tribe and their own traditions indicate a migration from the Ohio rather than the reverse, while the separation of the Iowa, Oto, and Missouri from the Winnebago seems to have been fresh in the minds of two of these peoples down into the last century.

[19] Alvord and Bidgood, First exploration of the Trans-Allegheny region, 87. 1912.
[20] See Bur. Amer. Ethnol. Bull. 30, article on Quapaw.

The occupancy of the territory of our Middle West between the great Lakes and the Ohio by Siouan tribes seems therefore to rest on grounds almost historical. With the strong indications now at hand there seems reason to think that a close comparative study of the Siouan dialects would enable us to reconstruct the general outlines of their ancient geographical positions with considerable accuracy. If present indications are not deceptive, when that is done we shall find that they fell into four major linguistic groups; a northeastern, consisting of the ancestors of the later Siouan tribes of Virginia, the Hidatsa, Dakota, Biloxi, and Ofo; a southeastern, including most of the later Siouan peoples of the two Carolinas; a southwestern composed of the five tribes of Dorsey's Dhegiha group; and a northwestern, Dorsey's Tciwere.[21]

Admittedly there is much of speculation in all this, but I have considered that the facts are of sufficient importance to both the ethnologist and the archaeologist of the Ohio region to present them in a usable form.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

870TH MEETING

The 870th meeting was held in the Cosmos Club auditorium, Saturday, October 21, 1922. It was called to order at 8:15 p.m. by President Crittenden. The attendance was 62.

Mr. WILLIAM BOWIE made a report on *The meetings of the International Geodetic and Geophysical Union and of the International Astronomical Union.* It was discussed by Messrs. PAWLING and WOODWARD.

Author's Abstract: The speaker prefaced his remarks by outlining the status of international scientific cooperative efforts before the outbreak of the war. Some years ago it was felt by scientists in various countries that it was necessary to cooperate to avoid duplication of effort and in order that each should know what methods and instruments were being used by others. Such desire on the part of scientists led to the formation of a number of associations, notably those of Geodesy, Seismology, Astronomy, Meteorology, and Geology.

The world war greatly interfered with international scientific cooperation and many of the associations were able to maintain only a nominal existence, through the efforts of the neutral nations of Europe.

Shortly after the close of the war there was held a meeting, in July, 1919, at Brussels, which provided for the creation of an International Research Council, with a number of branches called Unions, which, in turn, were subdivided into Committees or Sections. Two of the Unions created at

[21] I have purposely left the Mandans unplaced, but I do not believe that they will be found to occupy a position apart from all of the other groups.

Brussels were the International Geodetic and Geophysical Union and the International Astronomical Union. The former was divided into the Sections of Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Physical Oceanography, and Volcanology. The International Astronomical Union was divided into a number of Committees, each of which deals with some phase of astromical science.

It was proposed at Brussels that the two Unions should meet three years afterward at a time and place to be agreed upon. In the fall of 1921 the officers of the two Unions announced to the countries adhering to these Unions that the Italian scientists had invited them to meet in Rome, April 20, 1922. This date was later changed to May 2 because a large conference had already been planned for the latter part of April in Rome and it would have been difficult for the delegates to the two Unions to secure satisfactory hotel accomodations.

On the first day of the conference the delegates registered and presented their credentials, then attended the opening exercises at which the King of Italy and many other dignitaries were present. On the second day there were meetings of the two Unions. On the last day of the conference, which was May 10, there were also meetings of the two Unions, at which reports of certain committees which had been appointed during the first meetings were received, discussed and acted upon. During the intermediate days there were almost continuous meetings of the several Sections of the International Geodetic and Geophysical Union and of the Committees of the International Astronomical Union.

Much work was done at Rome, although there was some feeling that the time was quite short for such a large gathering and so many interests. It was practically impossible for a delegate representing one branch of science to attend more than the meetings of his own Section or Committee. However, the delegates left Rome with a feeling that much had been gained and that International cooperation in science had been restored and is now on a very firm basis.

Local scientists and officials entertained the delegates in the manner usual at such international scientific assemblages.

MR. ROBERT S. WOODWARD, presented a paper on *The compressibility of the Earth*. It was discussed by Messrs. LAMBERT, HAWKSWORTH, BOWIE, CURTIS, and L. H. ADAMS.

Author's Abstract: This paper considers the earth as a gravitating mass of homogeneous, concentric spherical shells in which there is continuity of increase in density from the external surface to the center of the sphere. The mathematical problem thus presented is defined by four relations, namely: (1) Poisson's equation, connecting gravitational potential and density at any point of the mass; (2) the hydrostatic law connecting potential, stress and density at any point of the mass; (3) the hypothesis of Legendre-Laplace, postulating that the rate at which stress increases with density is proportional to the density; and (4) the law of conservation of mass.

The problem is worked out on the assumption that the mean density of the earth is exactly twice the density of the surface crust. Data dependent on direct observations of the gravitation constant and on its relation to the mean density of the earth were cited to show that the mean density of the earth is very near to 5.514; while reference was made to the more recent investigations which seem to prove that the crustal density of the earth is very near to 2.76.

Expressed in a concrete application, the resulting compressibility is such that if the pressure of the atmosphere were doubled the surface of the earth

would move inwards nearly two meters (more exactly 185 centimeters, or 6.06 feet).

It was pointed out that this degree of compressibility finds important applications in geology, since it indicates that crustal subsidence and elevation amounting to hundreds, if not thousands, of meters may be due to variations in surface loads.

Reference was made to an earlier investigation by the author of "The effects of secular cooling and meteoric dust on the length of the terrestrial day" (Astronomical Journal, No. 502, July, 1901), in order to show that neglect of the compressibility of the earth in that investigation led to no sensible error.

871ST MEETING

The 871st meeting was held in the Cosmos Club auditorium, Saturday, November 4. It was called to order by President CRITTENDEN at 8:35 p.m., with 47 persons in attendance.

A paper by F. WENNER, NINA FORMAN, and A. R. LINDBERG on *The variation of metallic conductivity with electrostatic charge* was presented by Mr. Wenner. It was discussed by Mr. TUCKERMAN.

Author's Abstract: In the spring of 1921, Professor H. A. Perkins presented a paper to the American Physical Society in which he stated that a simple conception of metallic conduction based on moving electrons seemed to justify the assumption that a negative charge should increase the conductivity of a circuit and a positive charge should decrease it. He tested this assumption as follows:

A primary coil was wound upon a glass cylinder inside of which fitted a similarly wound secondary coil. The primary was excited through a 60 cycle circuit while the secondary circuit carefully insulated throughout included a moving coil galvanometer. At the same time the secondary circuit was given an alternating charge from one terminal of a high tension transformer, the other terminal being grounded. In operation the galvanometer was not affected either by the charging potential alone or by the induced alternating current alone. If, however, the induced current and the charging potential were both present, a large deflection of the galvanometer was observed. This phenomenon behaved in a perfectly regular manner and reversed if the phase of the charging E. M. F. were reversed by interchanging the terminals of the transformer.

An effect such as that just described would be of sufficient importance to require careful investigation, and some modification of our notions of metallic conduction. However, on repeating the experiment using reasonable precautions to prevent disturbing influences we observed no change in the deflection of the galvanometer on changing the phase between the current in and the potential of the test circuit. The arrangement of the circuit was such that on the basis of the explanation given the effect should have been larger than in the original experiment while the sensitivity of the galvanometer was such that a considerably smaller direct component of the current could have been detected.

This paper will be published in full in the December issue of the Physical Review.

By invitation, Mr. R. GILCHRIST presented a paper on *A new determination of the atomic weight of osmium*,[1] which was discussed by Messrs. HEYL, PAWLING, BURGESS, and HUMPHREYS.

[1] From a dissertation entitled "The Preparation of Pure Osmium and the Atomic Weight of Osmium" submitted to The Johns Hopkins University, June, 1922, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Author's Abstract: Pure osmium was prepared by making use of the following reactions. When OsO_4 and constant boiling HCl, in the presence of a small amount of C_2H_5OH, were heated in a reflux apparatus for about three hours, the OsO_4 was converted to chlorosmic acid, H_2OsCl_6. After evaporation to a syrup and dilution with H_2O, the osmium was precipitated as the brick red $(NH_4)_2OsCl_6$, with NH_4Cl. The $(NH_4)_2OsCl_6$ was reduced to metal in H_2. The H_2 was completely removed by nitrogen while the metal was still red hot. On cooling, gray osmium sponge resulted which was not attacked by the oxygen of the air.

The reagents employed in the above reactions were volatile ones which allowed of easy purification. The purification cycle could be repeated conveniently. Spectroscopically pure osmium was thus obtained.

The reaction between OsO_4 and 20 per cent HBr took place without the addition of C_2H_5OH, and was complete in about one-half hour. Bromosmic acid, H_2OsBr_6, was obtained in this case from which NH_4Br precipitated the black $(NH_4)_2OsBr_6$.

Two sources of osmium were used for the preparation of the salts for analysis. $(NH_4)_2OsCl_6$ was made from osmium obtained from Baker and Company. $(NH_4)_2OsBr_6$ was made from osmium obtained in the working up of some osmiridium residues recovered during refining of Russian crude platinum.

The results of the analyses were as follows:

BAKER AND COMPANY $(NH_4)_2OsCl_6$, SERIES I

EXPERIMENT	WEIGHT OF $(NH_4)_2OsCl_6$ IN VACUO	WEIGHT OF OSMIUM IN VACUO	OSMIUM	ATOMIC WEIGHT
	grams	*grams*	*per cent*	
1	1.46116	0.63688	43.587	
2	2.80587	1.22226	43.560	
3	2.32007	1.01021	43.542	
4	1.93756	0.84390	43.555	
5	2.92857	1.27597	43.569	
			43.563	192.074

$(NH_4)_2OsCl_6:Os = 100:43.563$

RUSSIAN $(NH_4)_2OsBr_6$, SERIES II AND III

EXPERIMENT	WEIGHT OF $(NH_4)_2OsBr_6$ IN VACUO	WEIGHT OF OSMIUM IN VACUO	OSMIUM	ATOMIC WEIGHT
	grams	*grams*	*per cent*	
1	4.17909	1.13522	27.164	
1	1.72778	0.46909	27.150	
2	0.98661	0.26783	27.146	
			27.153	192.172

$(NH_4)_2OsBr_6:Os = 100:27.153$

Average of eight experiments = 192.111

Os = 192.1

The complete paper will be published in the near future.

Mr. R. B. Sosman prefaced his paper on *Theory of the structure and polymorphism of silica*, by an informal communication describing an *Improvement on Whitlock's method of constructing models of crystal structure*, in which glass rods carrying the "atoms" are replaced by threaded brass rods. The paper was discussed by Mr. White.

Author's Abstract: There exists a wide variety of experimental data on the forms of silica, and particularly on quartz, which have never been assembled and explained on the basis of a single consistent set of hypotheses as to the ultimate structure of this substance. The author has attempted to provide such a set of hypotheses, based upon the general knowledge already gained concerning the structure of matter in general and silica in particular. It is believed that the silica atom-triplet maintains a certain degree of individuality in its amorphous and crystalline states as well as in its compounds, and the freedom of its oxygen atoms to change their positions with respect to the silicons is restricted. The triplets are assumed to assemble into chains or threads in the liquid and glassy states, and a thread structure persists in the crystalline states (cristobalite, tridymite, chalcedony, quartz). The high-low, or alpha-beta inversions in all the forms are thought to be due to the same underlying change, namely, a change in the state of motion of some subsidiary part of the atom-triplet, perhaps a pair of revolving electrons; this change results in an alteration of the relative positions of the two oxygen atoms attached to a silicon atom. Analogous phenomena of polymorphism are indicated in the silicates and in the dioxides of the other elements having an external electron structure similar to that of silicon (titanium, zirconium, germanium, tin). The paper will be published in full in the Journal of the Franklin Institute.

All three of the above papers were illustrated by lantern slides, and Mr. Sosman also showed models.

H. H. Kimball, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Dr. J. S. Ames, professor of physics, Johns Hopkins University, gave the first of a series of lectures on the Quantum Theory at the Bureau of Standards on January 8, 1923. It is the aim of this series of lectures to give a broad survey of the Quantum Theory to those unfamiliar with it, the final lectures to be given by Dr. A. Sommerfeld.

In his lecture Dr. Ames showed just where the hypothesis was introduced into physics. This was in the case of radiation from a black body, where the equations derived by methods based on classical mechanics were at variance with experiments. Planck made a modification, proposing that the energy vary by steps or by "quanta" hv, where v is the frequency of the radiation and h is a universal constant. This gave a law which agreed with experiment. That is, the theoretical black body was closely approximated in practice and the energy of the emitted radiation over the entire spectral range agreed in amount with that calculated from the radiation law.

A relation for the specific heat of a substance was derived as a function of temperature and hv, thus involving the hypothesis. The calculated and experimental values of those parts vital to the hypothesis were in agreement.

The mathematics essential to the development of two laws was given in the lecture. Dr. Ames emphasized that the Quantum Hypothesis rests on

an empirical basis and that it is accepted because it agrees with experiment in widely separated branches of physics.

MR. JOHN B. HENDERSON, a regent of the Smithsonian Institution, died January 4, 1923, in his fifty-third year. Mr. Henderson was born at Louisiana, Missouri, February 18, 1870. In spite of his many legal, political, and diplomatic activities he devoted much of his life to the study of marine biology and especially to the making of valuable collections of specimens many of which are now to be seen in the U. S. National Museum. Among his writings may be mentioned "*The Cruise of the Tomas Barrera.*" Mr. Henderson was a member of the ACADEMY and the following affiliated societies: Archeological, Biological, Geological, and Historical.

DR. A. S. HITCHCOCK of the Bureau of Plant Industry has been elected president of the Biological Society of Washington for 1923.

The election of Dr. T. WAYLAND VAUGHAN as president of the ACADEMY for 1923 was announced at the annual meeting on January 9.

DR. C. D. WALCOTT, Secretary of the Smithsonian Institution, was elected president of the American Association for the Advancement of Science at its annual meeting held in Boston, December 26–30, 1922.

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METEOROLOGY.—*The murmur of the forest and the roar of the mountain.*[1] W. J. Humphreys, U. S. Weather Bureau.

INTRODUCTION

Certainly for many centuries, perhaps from even the cave and stone age when men first began to associate one phenomenon with another, the murmur of the forest and the roar of the mountain have each been recognized as a meteorological symphony with the drive of the wind and the stress of the storm for its theme. As some one has pleasantly put it,

> "*The whispering grove tells of a storm to come.*"

And Lucan, the Roman poet, nineteen hundred years ago, solemnly warned us:

> "*Nor less I fear from that hoarse, hollow roar*
> *In leafy groves and on the sounding shore.*"
> —*Rowe's translation.*

Ages before this in turn Elijah told Ahab to hurry and eat and get down from Mount Carmel "for there is a sound of abundance of rain." And this sound, it would seem, could have been none other than the murmur of the forest, mingled, perhaps, with the roar of the mountain. "And it came to pass in the mean while, that the heaven was black with clouds and wind, and there was a great rain."

Such, then, has been the recognized weather significance through the ages of these mysterious aeolian effects. In many regions it is now, as it has long been, and as it indefinitely must continue, a common thing to refer to the "roaring" of a mountain as an indication of a general storm within six to twelve hours; and the "sign" is an excep-

[1] Presidential address.

tionally good one. Among the Alleghenies, to be specific, where the prevailing trend of the ridges is from northeast to southwest, this roaring is most persistent and pronounced with strong southeast winds. But these are the winds of the forward, or rainy, side of a cyclone whose center happens, as is often the case, to be 300 miles, or less, west to northwest of the place in question; hence the strong probability that the roaring of these mountains will soon be followed by bad weather. In these storms, averaging, roughly, two a month during summer and twice as many during winter, a number of distinct meteorological phenomena, including the roaring just mentioned, are often observed, the more conspicuous and more important of which it will be interesting, perhaps, to describe and profitable to explain.

The particular region here referred to, and in which the phenomena under discussion frequently occur, is the Gap Mills valley of Monroe County, West Virginia, between Peters Mountain, one of the finest of the Alleghenies, to the southeast, and Gap Mountain to the north-

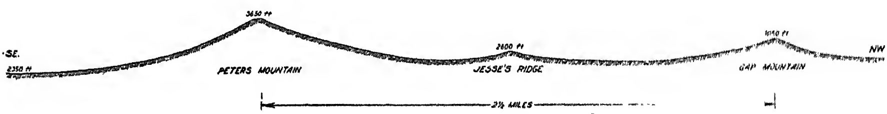


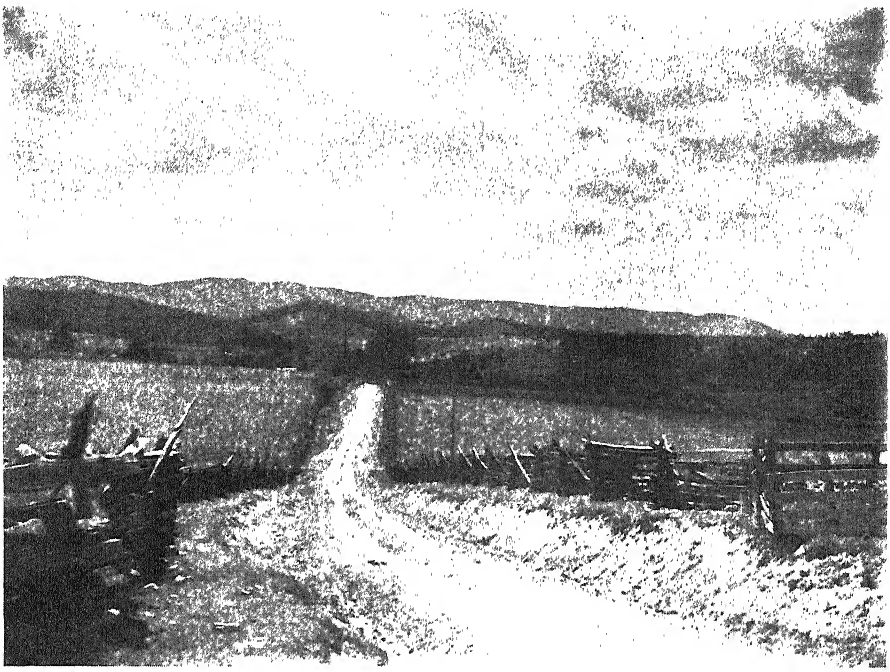
Fig. 1. Cross section of Peters Mountain and adjacent region

west. A cross section of this region, not, however, at the highest part of Peters Mountain, approximately to scale—2½ miles from crest to crest—is given in fig. 1. Some four miles beyond the crest of the larger mountain, to the southeast, is that of another mountain nearly as high, namely, 3800 feet, roughly, above sea-level and 1200 feet above the adjacent valleys. Beyond this in turn are still a few other ranges, mostly smaller, however, and more irregular. A typical view of the Gap Mills valley in which the roaring of the mountain and associated phenomena are so pronounced, and of Peters Mountain that does the roaring and causes most of the other phenomena to be discussed, is shown in fig 2. The Gap Mountain is off the picture to the right. The ridge in the middle background, known as Jesse's Ridge, and averaging about 200 feet in height, often is the cause of interesting secondary phenomena.

DESCRIPTIONS AND EXPLANATIONS

Although the murmur of the forest, the roar of the mountain, the winds that cause these sounds, and the usually accompanying clouds

and precipitation all are closely interrelated, some of them even in the sense of cause and effect, nevertheless, and for convenience, they are here discussed severally, and more or less independently, the whole constituting what might, perhaps, be regarded as a chapter on mountain meteorology.



(L. W. Humphreys, photo.)

Fig. 2. Peters Mountain and Gap Mills Valley

Opposing winds near top of mountain.—There occasionally are strong winds simultaneously up both sides of a high mountain ridge, such as Peters Mountain, near its top, when there are only light winds, or none at all, on the lower slopes and in the adjacent valleys. The explanation of this condition, which may or may not be associated with the coming of wide-spread cloudiness and extensive precipitation, consists of two parts: (1) How there may be a strong wind only near the top of a mountain, with but little or no appreciable movement of the air lower down and in the valleys. (2) How a strong wind can blow up one side of a mountain near its top at the same time that another strong wind is blowing up the other side, also near the top.

That a gale may exist across a mountain crest while the air is relatively calm below, is obvious from the facts (*a*) that adjacent layers of the air frequently have very different velocities, especially when the upper part of the under layer is colder than the under part of the upper layer, a condition that often occurs, and that permits the two distinct layers to flow, the one over the other, with but little intermingling, much as air flows over water; and (*b*) that in mountainous regions cold air, whatever its origin, tends, through its increased density, to fill the valleys and to become entrapped in them. Occasionally, therefore, the valley atmosphere, up nearly to the crests of the flanking mountains, is comparatively quiet while the air next above is moving rapidly directly across the trend of the ridges, and, of course, up so much of the windward sides of the mountains as projects into this over current.

But at the same time this wind of such obvious origin is blowing up one side of a mountain near its crest, a wind in the opposite direction, and also shallow, is rushing toward the crest up the other side. The explanation of this counter current, the second portion of the problem under discussion, requires a little of that strait-jacket logic of the physicist.

Let, then, the wind be in a steady state, constant at any place in direction, velocity, temperature, and density, and consider a tube of flow, that is, an imaginary tube of whatever size along which the air is flowing and across whose walls no air passes either in or out, just above the top of the mountain; let m_1 be the mass of air that passes the crest during a given interval of time along this tube; let v_1 be the volume of this mass as it passes, p_1 its pressure, and u_1 its velocity. Similarly, let m_2, v_2, p_2, u_2, be the corresponding values during the same interval of time for any cross section of the tube beyond the crest. Then, since the wind is in a steady state, $m_1 = m_2$. Furthermore, the simultaneous flows of energy along the tube by these two cross sections are also equal, because, as specified, no changes are occurring at any place. Finally, if the change of temperature of the surrounding air with change of altitude is strictly in keeping with the corresponding change in pressure—and in winds that are of the breeze order or stronger it is nearly so owing to their considerable stirring up, or turbulence—then the gravity contribution to the potential energy of a mass of air as it passes from one level to another is negligible, or, in other words, no appreciable work is required to lift a mass of air to a greater height or to pull it down to a lower level. There-

fore, to a close approximation, the sum of the volume energy and the velocity energy is constant. In symbols,

$$p_1v_1 + \tfrac{1}{2}mu_1^2 = p_2v_2 + \tfrac{1}{2}mu_2^2$$

or

$$v_1(p_1 + \tfrac{1}{2}\,\rho_1u_1^2) = v_2(p_2 + \tfrac{1}{2}\,\rho_2u_2^2)$$

in which ρ is the density. Hence, per unit volume,

$$p + \tfrac{1}{2}\rho u^2 = a\ constant.$$

Now, observation shows that ρu^2 is greatest near the crest of the mountain, as it is along the edge of any obstruction to a moving fluid. Clearly, then, this is also the place of least pressure within the tube of flow. Therefore, air must rush into the general current at this place (the assumed steady state cannot exist) and thus induce a corresponding wind up the lee side of the mountain near the crest.

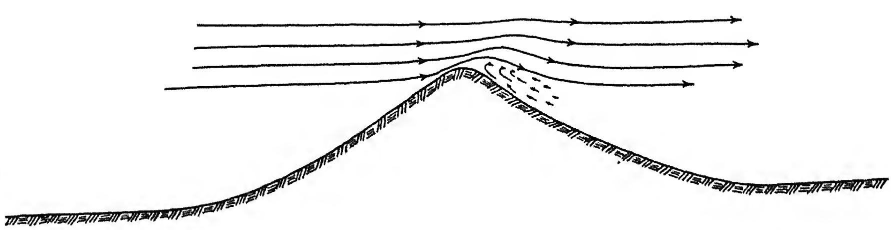


Fig. 3. Opposing winds near top of mountain

The above explanation embodies a form of the well known Bernoulli Theorem, hence it belongs to that finality class that precludes quibbling. Nevertheless, it is not quite so final as it seems, for viscosity was omitted, although, as everyone knows, contiguous portions of the atmosphere are so knit together by the thermal motions of their molecules that every blast of air more or less drags along the immediately adjacent air. This drag in turn leads to boundary turbulence and momentum interchange. Hence the upper portions of an under layer of air are caught up by any swifter wind above, and increasingly so with increase of velocity. In this manner also, in the case under consideration, the pressure in the surface air just beyond the top of the mountain on the lee side is decreased, and a wind up that slope is established and maintained.

When the upper wind crosses the valley at mountain height, as often happens, and as here assumed, the return current rapidly becomes

weaker, with distance down the slope, owing to surface friction and to the rapidly increasing cross section of the inflow, as indicated in fig. 3.

Exact mathematical and quantitative solutions of this and kindred problems, involving viscosity and turbulence, would, no doubt, be highly instructive, but such solutions have not been obtained. True, important progress has been made, but this progress, which is found chiefly in the turbulence papers of Rayleigh, Reynolds, Taylor, and Richardson, is not adapted to a brief and inclusive summation.

Return current.—When there is an appreciable wind from the mountain, there often is a lighter surface wind in the opposite direction up portions of the mountain itself, as indicated in fig. 4, and up the lee side of any paralleling ridge in the valley.. This, too, has no necessary relation to the gathering of clouds and the onset of precipitation, since it applies equally to winds crossing the mountain in

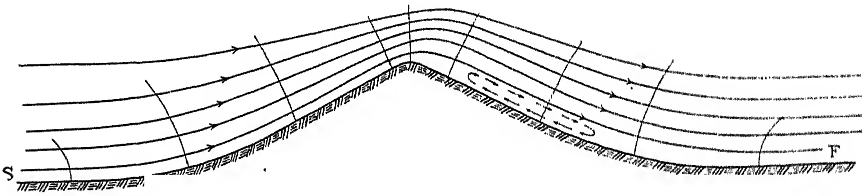


Fig. 4. Return current, and sound crossing mount

either direction. It differs from the opposing wind near the top of the mountain, just explained, in that it extends much farther down from the crest.

In this case the valleys contain but little if any stagnant air; the wind flows across the mountains in undulations more or less parallel to their sides, and the change of temperature with change of elevation is everywhere, owing to turbulence, in keeping with the corresponding change of pressure. That is, the change of temperature is due entirely to change of pressure, and not at all to loss of heat to, or gain of heat from, anything extraneous to the rising or falling mass of air.

In general the explanation of the return current is precisely the same as that given above of the opposing winds at the crest, except that as its cross section remains small (the parent wind being only a little above the surface) its velocity is correspondingly retained over a considerable distance down the mountain side.

During clear days the return current is strengthened by thermal convection; during clear nights, on the other hand, it is weakened if

not overcome or even reversed, by the tendency of the air along the slopes, owing to increased density due to loss of heat to the surface which, in turn, had cooled by radiation, to drain, or flow, away to lower levels.

Tempest belt.—When the wind across the mountain is strong, which it seldom is except in connection with a general cyclonic storm, it often beats down heavily on a narrow belt near, or beyond, the foot of the mountain—the stronger the wind the farther to leeward the tempest belt—while the winds both in the valley beyond and up the higher slopes are comparatively light, the latter indeed often being up the mountain and hence opposite in direction to that of the crossing and stronger wind. This tempest belt does not appear until the lower air, through the turbulence caused by the upper winds, has been brought to the same potential temperature throughout; that is, to such condition that each rising mass of air, if cooled by expansion only, or falling mass, if warmed by compression only, would, at every level, have the same temperature as has the adjacent air at the same level. In other words, this belt of driving winds does not form until the lower air is, by mixing, brought into a state of neutral equilibrium when, of course, convection requires but little work.

Clearly, then, when the lower air has been brought to this state of neutral equilibrium, the decrease of pressure along a mountain side owing, as explained above, to crossing winds, may be, and frequently is, sufficient to cause these winds to flow down closely parallel to the lee slope. The inertia of this descending current carries it on, and hence it often beats strongly on a belt near the foot of the mountain, where the slope has become gentle, or even somewhat out in the valley. Furthermore, just as the wind strikes with a downward component onto this belt, so too it rebounds from it with an upward component. Hence, beyond the tempest belt the winds are comparatively weak.

But the above may not explain the worst of these tempest winds. Since, as already stated, there are several mountains southeast of, and parallel to, Peters Mountain, and since the rains and snows of greatest duration come from that general direction, it follows that these mountains, and the valleys between them, get more precipitation than does the valley and adjacent section northwest of this highest ridge. Hence, occasionally, the former region may be snow covered and relatively cold while the latter has but little snow and is appreciably warmer. Under these conditions southeast winds on topping

Peters Mountain must, because of their comparatively great density incident to the low temperature, rush cataract-fashion down the lee side and onto the nearer portion of the valley. At such times the winds of the tempest belt are abnormally violent, and much like the famous Helm Wind along the west side of the Pennine range of mountains in northern England.

It may, perhaps, be worth while to call attention here to the all but obvious fact that when the lower air has been brought to neutral equilibrium, which it soon is after the surface winds become strong, an aviator can more easily cross a high mountain with the wind than against it—more easily when the currents boost him up than when they beat him down.

Smoking of chimneys.—When the wind is from the mountain it frequently happens that chimneys near its base, and even many in the valley, "smoke" in a most disagreeable, puffy, manner, a phenomenon locally interpreted to imply the approach of bad weather, a prediction that usually comes true. The cause of the smoking of chimneys at the time of winds from the mountain is, of course, perfectly obvious. As just explained, these winds have marked downward components, and some of the gusts are strong enough to drive well into an open topped chimney against the heated air, and send smoke and ashes whirling through the room. Hence in mountainous regions many chimneys are hooded as a protection against both the smoke nuisance and its inevitable fire hazard.

Sounds beyond the mountain.—At the very beginning of a general storm and before any other evidence of it is apparent, sounds made in a windward valley, or beyond, often are distinctly heard in the next valley to the leeward where at other times they are quite inaudible. This effect clearly is owing to the fact that the vibrating air, transmitting the sound with the velocity of about 1100 feet per second, is itself a part of the general wind. Since the velocity of sound has been closely determined for certain temperatures, and is known to vary as the square root of the absolute temperature, it follows that for any given variation of temperature with altitude and given corresponding direction and speed of the wind the path of any sound ray—any normal to the sound-wave front—can be traced with all desired accuracy. Under certain simple conditions, such as uniform changes of temperature and wind velocity with altitude, the path of a sound ray can be given in terms of a concise equation. However, it is not worth while here to indulge in any such mathematical diver-

sions, because actual winds are not so regular as these exact solutions would require, and because the general effect can best be shown graphically. Let, then, the wind blow more or less directly across a mountain, up one side and down the other parallel to the surface, and increase with distance from that surface, all of which occurs in nature. Obviously a sound wave-front travelling with such a wind tends more and more towards the vertical as it climbs the windward side of the mountain, crosses the ridge substantially upright, when the distance to the source and the wind velocity are in proper adjustment, and then focusses onto the leeward valley, all as diagrammatically illustrated in fig. 4, in which S is the source of the sound, and F its leeward focus, necessarily diffuse, as determined by the wind currents and indicated by the progressive positions of the wave front.

Roaring of the mountain.—At about the time the above transmontane noises are heard, or shortly thereafter, the mountain over which they come begins to produce a low sighing or moaning sound which in a few hours, particularly during winter, when the winds are strong and have free access to the eddy and vortex-producing twigs, often grows to a cataract roar.

This roaring of the mountain is a very striking phenomenon, especially to any one not accustomed to it. To the imaginative who know its cause, it ranges from the beautiful to the sublime; while to the superstitious it may run the whole gamut of horrors from the uncanny to the demoniacal, as illustrated by the following tradition:

It seems that the ridge shown in fig. 2, and which is about a mile and a half long, was owned first, some 150 years ago, by one Jesse Bland. But he soon lost it, it is said, by deeding half his place to a "witch doctor" to cure him of the witches, whose direful threats carried by the howling wind were ever more clamorous with the swell of the mountain's roar, and who night after night transformed him to a horse and furiously rode him 200 miles for a bag of salt—so he explained his night sweats—and shortly afterwards the remaining half to a lawyer to sue the witch doctor for not curing him. Today in this enchanting valley there lives neither witch, witch doctor, nor lawyer. Its people believe neither in folly nor in fuss. But the mountain still roars and at times one can sympathize with Jesse, or with the Esthonians of today who, attributing, we are told, the bitter northerly winds of spring to the spells of Finnish wizards and witches, are afraid to go out on Ascension Eve, or either of the other two Days of the Cross:—

"Wind of the cross! rushing and mighty!
Heavy the blow of thy wings sweeping past!
Wild wailing wind of misfortune and sorrow,
Wizards of Finland ride by on the blast."
—Popular Esthonian song.

The explanation of these curious sounds evidently goes back, not to wizards and witches as might formerly have been supposed, but to the action on the wind by a single twig or branch, for the differences between the whispering of the tree, the murmuring of the forest, and the roaring of the mountain, are essentially differences in degree and not of kind.

Now, it has long been known from the work of Strouhal[2] that wind normal to a cylinder, such as a stretched wire, produces aeolian tones even when the cylinder itself takes no part in the vibration; that the pitch of the note thus produced, independent alike of the material, length, and tension of the wire, varies directly as the speed, u, of the wind and inversely as the diameter, d, of the obstructing rod; and that the number, n, of such vibrations per second is given, approximately, by the equation

$$n = 0.185\ u/d$$

the units being the centimeter and second.

An excellent example of such sounds is the familiar singing or humming of telegraph and telephone wires.

Whenever the tone produced as above described coincides with one of the proper tones (fundamental or a harmonic) of the wire, the wire itself, if suitably supported, then vigorously vibrates, normal to the direction of the wind, and thereby increases the loudness and produces other interesting results. These, however, will not be considered further since the twigs and branches of trees, whose aeolian effects alone are here under discussion, have no free periods of importance in this connection.

The sounds in question, that is, the tree and forest sounds, therefore, are not due to the elasticity of the twigs and branches, but, as in the case of the singing telegraph wires, to the instability of the vortex sheets their obstruction introduces into the air as it rushes by them. This obvious and, indeed, unavoidable deduction from Strouhal's experiments, just referred to, has been abundantly confirmed by cinema photographs of water eddies, due to flow past a cylinder. Vortex whirls develop in the flowing water at regular

[2] Ann. d. Phys. **5**: 216. 1878; see also Lord Rayleigh, Phil. Mag. **29**: 433. 1915.

intervals, alternately on the one side and then on the other, of the interfering cylinder, while the eddy mass vibrates from side to side in the same period.

The complete mathematical analysis of these and similar vortices, giving the deduction of Strouhal's rule, and many others, would be both interesting and valuable, but it appears that this important problem has not yet been fully solved. Clearly, though, if all twigs and branches had streamline shapes—shapes over and along which a current of air will flow without vortex agitation—and were properly oriented to the wind there would never be a whisper from a tree nor

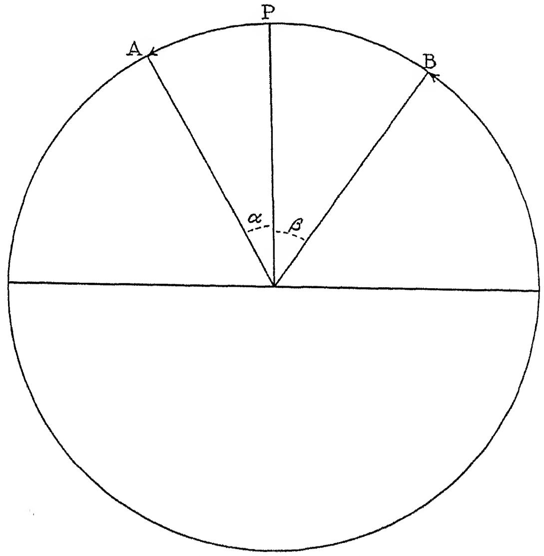


Fig. 5. Phase circle

murmur from a forest. But they are not so shaped; trees do have voices, and voices that are even characteristic of the species. The muffled plaint of the oak at the wintry blast, for instance, has but little in common with the sibilant sigh of the pine. And the reason is obvious. The twigs and branches of the one, because relatively large and of many sizes, produce a multitude of low tones, while the innumerable fine needles of the other give a smaller range of high-pitched notes.

It remains now to determine how a multitude of sounds, such as twig-produced aeolian notes, blend together—how the pitch and loudness of the resultant are related to the like properties of the elementary constituents.

Let two sounds have the same amplitude, but slightly different frequencies, a and b, $a > b$. Let them start together with maximum displacement, or at the top, P, of the phase circle, fig. 5. Let the phase position of the quicker, after a few intervals, and at the instant when the resultant amplitude is at a maximum, be at A (having described the angle $2n\pi + \alpha$, n being a whole number) and that of the slower at B (having described the angle $2n\pi - \beta$); let s be the velocity along the circumference of the phase circle of the slower, and $s + \delta s$ the correspnding velocity of the quicker. Then, since the combined amplitude is at a maximum,

$$s \sin \beta = (s + \delta s) \sin \alpha, \text{ and } \beta > \alpha.$$

For the next maximum

$$s \sin (\beta + \delta\beta) = (s + \delta s) \sin (\alpha + \delta\alpha), \delta\alpha > \delta\beta,$$

and so on for succeeding maxima.

Furthermore, since the rate of increase of an angle is greater than that of its sine, the successive values of $\delta\beta$ will slowly increase so long as β and α are greater than 0, and less than $\pi/2$, and then increase while they are greater than $\pi/2$ and less than π. In short, the combination tone will have a varying pitch intermediate between those of its constituents. And this is also true of any number of constituent sounds—whatever their initial and subsequent phases their resultant always has a quasi-average pitch. Hence, as is well known, the hum of a swarm of bees is pitched to that of the average bee, and the concert of a million mosquitoes is only the megaphoned whine of the type.

This problem may of course be concisely treated analytically, but the above simple method is sufficient for the present purpose.

The final law of sound essential to the explanation of the roar of the mountain, namely, the intensity of a blend in terms of that of its constituents, has been found by Lord Rayleigh[3] in substantially the following manner:

Let the number of individual sounds be n, all of unit amplitude and the same pitch, but arbitrary phase—conditions that approach the aeolian blend of a forest, or even a single tree. Clearly, if all the individual sounds had the same phase, and unit amplitude, at any given point, their combined intensity at that point would be n^2. If, however, half had one phase, and half the exactly opposite phase, the intensity would be zero. Consider then the average intensity

[3] Encyclopaedia Britannica, 9th ed., "Wave Theory." Scientific Papers **3**: 52.

when all the vibrations are confined to two exactly opposite phases, $+$ and $-$. Now, the chance that all the n vibrations will have the same phase, $+$ say, is $(\frac{1}{2})^n$ and the expectation of intensity corresponding to this condition $(\frac{1}{2})^n n^2$. Similarly, when one of the vibrations has the negative phase and the $n-1$ others the positive phase, the expectation is $(\frac{1}{2})^n n(n-2)^2$; and the whole or actual expectation

$$(\tfrac{1}{2})^n \left\{ 1.n^2 + n(n-2)^2 + \frac{n(n-1)}{1.2}(n-4)^2 + \ldots . \right\} \qquad \text{(A)}$$

The sum of the $n + 1$ terms of this series is n, as may be indicated by a few numerical substitutions; or proved, as Lord Rayleigh (*l. c.*) has shown, by expanding the expression

$$(e^x + e^{-x})^n$$

into the two equivalent series

$$2^n (1 + \tfrac{1}{2}x^2 + \ldots\ldots)^n \qquad \text{(Maclaurin)}$$

and

$$e^{nx} + ne^{(n-2)x} + \ldots . \qquad \text{(Binomial)}$$

developing the exponentials into series of algebraic terms, and, finally, assembling and equating the coefficients of x^2 in the two equivalent series, and solving for n. The value of n thus found is identical with the expression (A).

That is, on the average, the intensity of the resultant of n sounds of unit amplitude, but confined, in random numbers, to two opposite phases, is always n, whatever its numerical value.

If, instead of the numbers of sounds in either of two opposite phases being random, the phases are random, the result, as Rayleigh has shown, is the same.

It should be noted that n is only the mean intensity of a possible range from 0 to n^2, and not the continuous intensity. But when the changes are rapid the fluctuations from the mean are correspondingly inconspicuous.

From the above two laws, namely, (1) that the pitch of a composite note is the approximate average of those of its constituents, and (2) that the mean intensity is the sum of the individual intensities, it appears (*a*) that the pitch of the aeolian murmur of a forest is essentially that of its average twig, or needle, if the forest be of pine, and (*b*) that though the note of the twig may be inaudible, even at close range, the forest often may be heard miles away.

The explanation of the roar of the mountain, most pronounced during winter when the trees are bare and the winds strongest, is now obvious. It is only the feeble notes of the myriads of forest twigs at and near the mountain top merged into a mighty volume of sound of a more or less average pitch, all focussed, as shown by fig. 4, on the valley beyond, but so crudely and variably focussed as to cause great fluctuations in the intensity.

Clouding of mountain crest.—At the same time, approximately, that the mountain begins to roar, its crest usually becomes cloud capped, even when all other portions of the sky are absolutely clear. As already explained, this roaring commonly is in response to the strong and persistent winds on the forward side of a cyclonic storm, the side where, because the wind is from the southeast, roughly, the clouds thicken and rain begins. As also previously explained, the wind is necessarily from the southeast over Peters Mountain when its roar is heard in the adjacent northwest valley—the particular circumstance here under discussion. Of course this mountain, and others similarly oriented, roars to its opposite, or southeast, valley in response to northwest winds; but these winds generally are relatively weak or of comparatively short duration and the roaring they produce correspondingly inconspicuous. They, therefore, will not be further considered in what follows.

The southeast winds, then, over this mountain, coming, at least in their greater distances, from relatively warm and humid regions, progressively approach saturation. Furthermore, it is the under layers, in general, of the air that contain the largest amount of moisture, partly because of their higher temperature and consequent greater moisture capacity, as we elliptically (if not even cryptically) express it, and partly because the source of this humidity—bodies of water, and growing vegetation, chiefly—is at the surface of the earth.

After a time, then, the lower layers of the atmosphere become so humid that their cooling by expansion as they rise over the mountain carries their temperature below the dew point, and thereby produces a cloud along the mountain crest. At first this cloud, continuously formed by condensation on its windward side, is continuously evaporated on its leeward side. That is, it is a stationary cloud though its every droplet is in rapid motion and of short duration. It is a local condition in the flowing air just as a waterfall is a local condition in the passing stream.

Drifting of scud.—The leeward side of the crest cloud, just explained, is dragged out in irregular fragments by the gusts and swirls of the

passing wind and driven, as flying scud, down the mountain to quick oblivion—rapid disappearance through evaporation, owing to the increase of temperature that results from the gain of pressure always incident to loss of level.

Isolated cloud billow.—As the scud fleeces grow in size and number, a detached cloud bank of the roll-cumulus type forms over the leeward valley parallel to the mountain crest. At first this cloud is narrow and often broken, but it soon grows wider, deeper, and darker. It is more or less agitated, but as a whole remains fixed in position.

The inertia of the air, as it sweeps up and over the mountain, carries it to an elevation more or less above its level of equilibrium, from which elevation it drops back farther on, and again, like the swinging pendulum, passes beyond its point of rest. In this way a few rapidly damped billows are set up parallel to the mountain crest just crossed. That is, the air rises first above the mountain, then falls to a lower level, rises

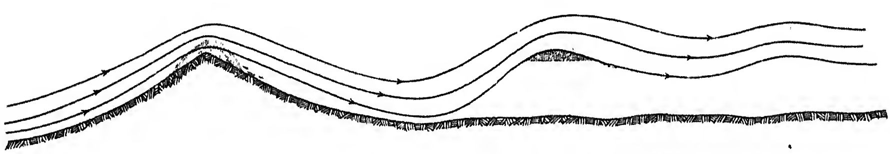


Fig. 6. Stationery clouds on mountain and over valley

again (affording the soaring bird easy toboggan sailing), and so on in rapidly decreasing amplitude. Hence, as the humidity of the air increases, first a slight cloud forms a little above and to the leeward of the mountain ridge along the crest of the topping billow, while the crest of the next billow beyond, being at a lower level and therefore warmer, is entirely cloudless; then, with further increase of humidity, this initial cloud thickens until it rests on the mountain top and gives off continuously avalanches of scud—scud that evaporates in its first descent, condenses on rising to the next billow crest, and again evaporates as it passes on and down the farther side of this aerial wave, all as schematically illustrated in fig. 6.

It is this convectionally-recondensed scud at the crest of the first air wave beyond the mountain ridge that constitutes the isolated roll of cumulus cloud along the leeward valley, a cloud that is continuously formed and as continuously evaporated, a permanent cloud of fleeting particles, and stationary because the crest of the billow is fixed in position.

By, and commonly before, the time this stationary cloud has formed over the valley, the air has become so thoroughly mixed that most of the wind phenomena described above are fully developed. In particular the descending currents reach the earth along the tempest belt and there rebound, giving the mysterious leeward calm beyond.

Complete clouding.—Commonly the crest cloud along the mountain grows heavier, the scud thicker and more enduring, and the bank of stationary cloud over the leeward valley broader and deeper until all merge together and the whole sky is blotted out by a continuous cloud canopy; a sequence of phenomena owing entirely to the increasing humidity of the air, and the consequent lowering of the dewpoint, as the wind continues to blow from warmer and more humid regions.

Rain or snow.—Shortly after the clouds have merged into a continuous sheet, precipitation usually begins, and commonly lasts anywhere from several hours to an entire day, or even two days. It is the final result, in part, of the increased humidity of the winds, and also in part of the convection and consequent cooling of the air incident to the cyclonic storm then prevailing.

After the rain, or snow, there follows, of course, the process of clearing up, but this process has no distinct mountain peculiarities and hence need not be discussed here.

There are of course still other phenomena that might be considered in this connection, but the above are, perhaps, the more interesting and the more important of the many generally associated with the roaring of the mountain, and enough to assure us that among forested mountains, especially

> "*In winter, when the dismal rain*
> *Comes down in slanting lines,*
> *And Wind, that grand old harper, smites*
> *His thunder-harp of pines,*"—
>
> —*Alexander Smith.*

when the muffling leaves are gone and the twigs are free to mingle their myriad aeolian tones, the coming storm is heralded by the murmuring of the forest and the roaring of the mountain. In proverb form:

> *When the forest murmurs and the mountain roars,*
> *Then close your windows and shut your doors.*

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

872D MEETING

The 872d meeting was held in the Cosmos Club auditorium, Saturday, November 18, 1922. It was called to order at 8:25 p.m. by President CRITTENDEN, with 40 persons in attendance.

Mr. C. E. VAN ORSTRAND addressed the Society on *Deep-Earth temperatures in the United States*. The address was illustrated by lantern slides, and was discussed by Messrs. CRITTENDEN, HEYL, PAWLING, GISCH, WHITE, HUMPHREYS, PRESS, and HAWKSWORTH.

Author's Abstract: The application of electrical methods to the determination of temperatures at great depths was discussed, but the instrument which seems best adapted for general use in making a geothermal survey is the maximum thermometer. Apparatus for use in connection with maximum thermometers was described. Tests in a great number of wells show that an accuracy of 0.1 or 0.2°C. can be obtained when working under favorable conditions. The chief source of error is the lack of temperature equilibrium in the wells.

A brief discussion of the data of observation from mines, and both flowing and non-flowing wells, was given. This feature of the investigation has not yet been carried to a point where definite conclusions can be stated.

A paper by K. S. GIBSON and E. P. T. TYNDALL, on *The Visibility of Radiant Energy* and illustrated by lantern slides was discussed by Messrs. PAWLING, PRESS, and CRITTENDEN.

Author's Abstract: By the visibility of Radiant Energy is meant the ratio of luminosity to radiant power at the different wave-lengths (or frequencies) in the spectrum. In cooperation with the Nela Research Laboratories, a new determination of this function had been made at the Bureau of Standards. The so-called "step-by-step" method was used, which is an equality-of-brightness simultaneous-comparison method, in which there is little or no color difference in the two parts of the photometric field. Fifty-two observers were tested, some of them common to previous investigations.

The final results are not greatly different from those obtained in other investigations, and comprise further evidence on the comparison of equality-of-brightness and flicker photometry.

INFORMAL COMMUNICATIONS

W. J. HUMPHREYS referred to the various factors that appear to enter into the determinations of latitude. Among others, it had recently been found in England that there appears to be a variation of latitude with the velocity of wind. The question was further discussed by Messrs. WHITE, LAMBERT, and PAWLING.

Mr. PAWLING reported that recently he had made a setting with a telescope at the U. S. Naval Observatory on a star that apparently was not catalogued. He was uncertain whether it was a variable start, or one that had been accidently omitted from the Star catalog.

SCIENTIFIC NOTES AND NEWS

Mr. A. E. Ruark gave the second of the series of lectures on the Quantum Theory at the Bureau of Standards on January 15, 1923. The quantum theory of spectroscopy and the Balmer series of hydrogen were discussed, the fundamentals of the theory being taken up in historical order. Mr. Ruark dealt with the two suppositions made by Bohr to explain the spectrum lines of hydrogen and the ionized helium atoms:

(1) When the atom is not radiating, its single electron and its nucleus move in circles around their common center of gravity in conformity with ordinary dynamics, but the circles on which they can move are restricted to a finite number by the *quantum condition* that the angular momentum of the entire atom must be an integral multiple of $h/2\pi$ where h is Planck's constant; however, the nucleus is so heavy compared to the electron that it moves on a circle very small in comparison to the electronic orbit.

(2) When the electron passes from one of these circles to another, where the system has less energy, the energy E which is given up is transformed into a train of light waves of frequency ν, where ν is determined by the equation $E = h\nu$. Sommerfeld has extended the theory to the case of elliptic orbits, and has discussed the effect of change of mass of the electron due to its velocity thus obtaining an explanation of the fine-structure of the hydrogen and helium lines. Wilson and Sommerfeld have formulated the general quantum conditions which determine the discrete orbits possible in any system of particles with conditionally periodic motion; these include Bohr's postulate concerning the angular momentum as a special case. Rubinowicz and Bohr have explained by the "correspondence principle" and the "principle of selection," respectively, the absence of certain components of spectral lines, predicted by the above theories, so that satisfactory agreement between theory and experiment has been achieved in all respects.

The Petrologists' Club met on Tuesday, January 16. Mr. E. S. Larsen spoke on *The probable hydrothermal origin of some corundum deposits.* He divided the deposits into two classes, one in which solutions emanating from magmas introduced corundum together with other minerals into surrounding rocks; and another including those formed as veins in peridotites by solutions believed to be the last liquid of the peridotite itself.

A Joint Resolution has been passed by the Senate and the House of Representatives reappointing Mr. Henry White as a Regent of the Smithsonian Institution, appointing Mr. Frederic A. Delano to succeed the late John B. Henderson, and Mr. Irwin B. Laughlin to fill the vacancy caused by the expiration of the term of the late Alexander Graham Bell.

The National Gallery has now on exhibit in the Evans Room a collection of antique Etruscan, Greco-Roman and Byzantine jewelry, ancient glassware and pottery, dating from the Seventh Century, B.C. to the Eleventh Century, A.D., lent by the Archaeological Society of Washington.

A considerable collection of antiquities from a pit house in Chaco Canyon, New Mexico, was presented to the U. S. National Museum in January by the National Geographic Society and is now being cataloged in the Division of American Archeology. Objects from the subterranean dwellings are extremely rare, for the pit houses antedate most of the prehistoric Pueblo

ruins of the southwestern United States and traces of them have usually been entirely effaced.

Mr. George W. Hoover, chief of the Chicago Station of the Bureau of Chemistry, has been appointed chief of the newly created Drug Control Laboratory. Mr. M. W. Glover, who has been in charge of the Office of Drug Administration, has been recalled to the U. S. Public Health Service, and Dr. L. F. Kebler, chemist in charge of the Division of Drugs, has been promoted to the position of chemist in charge of special collaborating investigations and will direct the work involved in the enforcement of the Postal Fraud Law.

Dr. A. Hrdlicka lectures every Friday afternoon, from 5 to 6 o'clock, at the Postgraduate school of the American University, 1901 F Street, on Human Variation, i.e. variation in man's characteristics, both physical and functional. Those who may be interested are invited to attend.

ANNOUNCEMENT

Professor Sommerfield will give the following course of lectures at the Bureau of Standards at 4 p.m. as follows:

Subject	Date
1. Introduction to Quantum Theory and Its Place in Modern Physics..	March 2
2. Quantum Theory of Spectroscopy, Balmer Spectrum of H, etc......	3
3. Atomic Structure of the Chemical Elements......................	5
4. Wave Theory and Quantum Theory............................	6
5. The Significance of Quantum Numbers, azimuthal, radial, equatorial, inner, etc..	7
6. Zeeman Effect, Theory of Magneton............................	8
7. Line Structure in Complicated Spectra...........................	9

All persons interested are invited to attend. The Bureau of Standards is located at Connecticut Avenue and Van Ness Street, Washington, D. C.

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PHYSICS.—*The measurement of light.*[1] E. C. Crittenden, U. S. Bureau of Standards.

INTRODUCTION

I believe that custom allows the annual address of your retiring president to differ from other papers presented before the Society in at least one important respect. Others are expected to bring before you something original in theory, mathematical development, or experimental data. Your president, however, is permitted to choose his own subject without having to convince the Committee on Communications that it will involve an addition to our knowledge of physical science. Taking advantage of this liberty, I have chosen to talk on the subject of the measurement of light, with the intention of discussing problems which will be quite familiar to many of you, and of summarizing established facts rather than attempting to set forth any new ones. My reasons for so doing are two-fold. First, there has recently arisen in the scientific and technical press an unusual amount of discussion of this general subject; and second, some of the published discussions, as well as questions which have come up otherwise, have indicated that there is a certain degree of haziness in our general ideas on the subject.

It is perhaps well to recall also that during the year just past the Society has been favored with two important papers rather closely related to this subject. Dr. Troland in January gave us a carefully reasoned discussion of general principles applying to the study of problems of sensation, which involve physiological and psychological processes as well as physical stimuli. More recently Dr. Gibson has presented the results of his thorough-going experimental determina-

[1] Address of retiring President, Philosophical Society of Washington, January 13, 1923. The text has been modified as made necessary by omission of slides and other illustrative material used in its presentation.

tion of the relative effectiveness of radiant energy in different parts of the spectrum in producing the sensation of brightness under certain conditions. This paper bears directly upon the problems which I wish to discuss later, but first it is desirable to consider some matters of nomenclature and units.

DEFINITIONS AND UNITS

Light.—The word "light" itself is used in many different senses, but for the present purpose I wish to restrict it to a specific one. For this I must perhaps beg the indulgence of some of our members. I know there are some who cherish a little of the ancient sun-worshippers' reverence for light as the mystic agency which stirs into being the processes on which all life depends, and which surrounds us with warmth and beauty. I trust, however, that a prosaic limitation of the term for our present purposes will not lessen anyone's enjoyment of the beauties of the sunset, weigh down the buoyancy which an azure sky gives to our spirits, dim our appreciation of the iridescence which the oil film shows in lowly places, nor blind us to any other of the thousand and one glories which light provides for our enjoyment. If we are to consider light in any quantitative sense we must agree on some precise definition.

The definition which I propose to use may be stated as follows: "Light is radiant energy evaluated in proportion to its ability to stimulate the sense of sight." With respect to the ancient question whether there is then any light when no eye is present to perceive it, this definition is in a way a compromise. The physical radiant energy *is light, but how much light* it is can only be told by applying coefficients depending on the properties of the visual apparatus. According to this definition ultra violet and infra red radiation are therefore not "light." In order to emphasize the similarities of radiations of different wave length it is perhaps allowable to follow Tyndall's example in speaking of "Light, Visible and Invisible," but for precise discussion there are good reasons for adhering to the stricter definition which brings in the coefficient of sensation.

There are in fact many authorities who would go further and say that the term "light" can properly be used only for the sensation aroused by radiant energy, but this can never be a quantitative definition, because we can not measure sensation except in a roughly approximate way. The sensation produced depends on the state of the physiological apparatus involved, so that the amount of sensation produced by radiation of the same kind and amount is widely different

at different times. Moreover, at any given time, sensation is not proportional to the amount of the physical stimulus. In other words, in psychological effects two and two do not make four, and such effects can not well be used as a measure of other quantities. A condition somewhat analogous to this is represented by what the economists call the "law of diminishing returns." For the individual ultimate consumer at a given time two apples are seldom worth twice as much as one, and yet no one would deny that they are twice as many. So in the case of light it would be quite impractical to say that the quantity is doubled only when the sensation is doubled. In actual practice we must have some name which designates the quantity, partly physical, partly physiological and psychological, which represents an amount of radiant energy with due allowance for the usefulness of that particular kind of radiant energy for purposes of vision. The most practical course is to use the term "light" as is done in common speech.

It must be granted, however, that such expressions as "light is emitted from a lamp" or "the light falls on the page" are logically somewhat peculiar, since in these cases the actual phenomena involved are purely radiation, and the visual factor comes in only by a sort of mental juggling. We may perhaps imagine that as the radiation passes from lamp to book some spirit tags each element of it with a coefficient suitable to its frequency, which coefficient represents the magnitude of the effect which will be produced when the radiation reaches the eye. The thing which actually exists in space in definite amounts is radiant energy; the visual factor is obviously not really applied until this energy is absorbed by the visual apparatus and changed into a distinctly different form. In brief, *light in this quantitative sense has no real physical existence.* This fact is an argument against the proposals which have been made to simplify nomenclature by using the same names for units of light as for energy. It has been urged that the unit of light flux be that amount produced by one watt of radiant power at the most effective frequency, and that this unit also be called a watt. As an illustration of the practical confusion which would result from such a nomenclature it may be said that the lamp known as a "60-watt" at present would give about one "watt" of light flux. While this would serve to emphasize how far our practical illuminants fall below the most efficient monochromatic radiation, this advantage would hardly compensate for having two "watts" of entirely different kinds. Since the physiological-psychological sensation factor must come in in the translation of energy

into "light" there is no real disadvantage in passing over to entirely different units at the same time.

Derived Quantities.—If we may then start with this half-imaginary quantity which we call "light" and which is simply energy with the proper kind of tag on it, all the other things with which one has to deal in photometry and illumination follow logically. In nearly all illumination problems we are concerned with the rate at which light is supplied. Letting Q be the amount of light, then $\frac{dQ}{dt}$ = luminous flux (F), that is, the rate of flow of light. In order to deal with this flow mathematically it is frequently necessary to consider three derived quantities, (1) density of flow or flux per unit area $\left(\frac{dF}{dS}\right)$, either from, to, or through a given surface, (2) divergence of flow or flux per unit solid angle $\left(\frac{dF}{d\omega}\right)$, and (3) a combination of these, flux per unit solid angle per unit of projected area $\left(\frac{d^2F}{dSd\omega\cos\vartheta}\right)$. These three latter quantities are, of course, applicable in all kinds of problems, such as that of calculating the flow of light through a projector or other optical system, but more commonly they are used in restricted senses for which special names have been given. The flux per unit area on a surface is its illumination (E), the flux per unit solid angle from a source is its intensity or candlepower (I), the flux per unit solid angle per unit of projected area of a light source is its candlepower per unit of projected area, or brightness. The source concerned need not be a self-luminous one, since the same reasoning will apply to light diffusely reflected or transmitted. Volume sources, such as flames or the sky, have to be considered as virtual surfaces, but this introduces no serious difficulties and is in effect what the eye itself does.

Units.—We have so far talked about these quantities without attempting to tie them up to any definite magnitudes. When we come to the matter of units and actual measurements difficulties arise in following out the logical scheme outlined. It is agreed that the ultimate basis of measurement is to be the effect on the eye, but all that the eye can do quantitatively is to equate brightness. We must somewhere make an arbitrary start in order to establish a system of units. As a matter of history you all know that this has been done by adopting a certain value for the candlepower of some kind of light source, so that historically the candle is the basic unit. From this

followed the foot-candle and the meter candle (also called lux) which, as the names show, were originally defined in terms of candlepower and distance rather than of flux density. The unit of flux itself, the lumen, is in practice defined as the flux through a unit solid angle from a source of unit candlepower, and going farther backward on our scheme the unit of "light" is not even dignified by a distinctive name, but is called the lumen-hour.

TABLE I.—PHOTOMETRIC QUANTITIES

QUANTITY	DERIVATION	SYMBOL	SPECIAL NAMES	UNITS
Light	Energy x V	Q		Lumen-hour
Luminous flux	$\frac{dQ}{dt}$	F		Lumen
Density of flow Flux per unit area	$\frac{dF}{ds}$	E	Illumination (on surface)	Foot-candle Meter-candle Lux
Divergence of flow Flux per unit solid angle	$\frac{dF}{d\omega}$	I	Intensity Candlepower (of source)	Candle
Flux per unit solid angle per unit projected area Candlepower per unit projected area (of source)	$\frac{d^2F}{d\omega\, dS \cos\theta}$	B	Brightness	Candle per sq. in. Candle per cm^2 (Lambert = $1/\pi$ candle per cm^2.)

Note.—The nomenclature of this table departs from recognized practice in the use of the term light and the symbol Q for it. The practice approved by the American Engineering Standards Committee is set forth in Illuminating Engineering Nomenclature and Photometric Standards, a pamphlet obtainable from the Illuminating Engineering Society, 29 West 39th Street, New York City.

Brightness is of course most simply specified in candles per square inch or per square centimeter; but another unit, the lambert, has found considerable use. The lambert is $1/\pi$ candle per square centimeter. The reason for using this apparently peculiar unit is most readily explained by an example. If a perfectly diffusing white wall is illuminated it becomes a secondary source of light, but the reflected light is so distributed throughout a hemisphere that the brightness of the wall in candles per unit area is only $1/\pi$ times the illumination. The lambert is the brightness of a perfectly diffusing, completely reflecting surface under a unit illumination, that is one centimeter-candle, which means receiving one lumen per square centimeter. The

lambert may therefore be defined as the brightness of a perfectly diffusing surface emitting or reflecting one lumen per square centimeter. This represents a high degree of brightness for a secondary source. A white surface in the brightest direct sunlight would have a brightness of only 10 lamberts, and for most cases of illuminated surfaces, the millilambert, or 0.001 lambert, is more convenient. The millilambert is the brightness of a perfectly white surface with 10 meter-candles illumination, and since a foot-candle is somewhat over 10 meter-candles (the actual ratio being 10.76), the millilambert represents almost exactly the brightness of an actual white surface, such as magnesium oxide or carbonate, under an illumination of 1 foot-candle.

A special case in which a still smaller unit, the microlambert (one-millionth of a lambert), is used, is the measurement of radio-active self-luminous materials. The brightness of these materials as actually used is a few microlamberts. That is, they are as bright as a white surface receiving a few thousandths of a foot-candle; for comparison, it may be noted that full moonlight is several hundredths of a foot-candle, giving to a white surface a brightness ten times as great as these materials show.

Referring to the table of units we have constructed (Table I), it may be noted that the light output of a source can be specified in two ways. We can either state the flux in lumens or give the average intensity or candlepower over a specified solid angle, usually the complete sphere. From the point of view taken in making up this table it appears that the former practice is simpler, but on the other hand the historical development favors the second, and in other countries than this the flux rating has gained little use in practice. In this country, however, the lumen has rapidly attained an extensive use as a practical unit for two reasons. One is that for rough and ready calculations of illumination the lumen is more convenient. For example, if one has to provide an area of 2000 square feet with an average illumination of 5 foot-candles the product 10,000 immediately gives the net amount of flux required. A more potent reason, however, is the fact that so long as candlepower is considered to indicate light output, misunderstandings are bound to occur, and misrepresentation is facilitated. For instance, when a lamp rated at 21 candles is put in a headlight reflector and gives a candlepower of many thousands, it is not surprising that the non-technical man is puzzled. Even a technically trained man is likely to overlook the fact that watts per candle for one kind of lamp do not mean the

same as for another, and the continual necessity for specifying what kind of candlepower one means is a strong argument for using the unambiguous "lumen." Incidentally the appropriate use of the flux rating which tells how much light is produced serves to make more clear the real significance of candlepower as indicating the distribution of the flux about the source.

STANDARDS OF CANDLEPOWER

Primary Standards.—While all countries agree in making their measurements start from concrete standards of candlepower, and general agreement, with the exception of the Germanic nations, has been reached on a common unit of candlepower, there has been wide divergence in regard to the standards which shall be considered as fundamental. In all countries the name given to the unit is candle, or an equivalent word, but no country has actually retained the candle as a standard. In passing from it, however, each country has followed an independent course, and consequently the nominal basis of the unit is different in each of the four great nations, France, Great Britain, Germany and the United States. The first three of these adopted different flame lamps as primary standards. If the units were actually redetermined from these standards it is probable that differences would appear among the units thus derived.

In France the classic basis for the value of the candle is the Violle platinum standard (the normal intensity of one square centimeter of platinum at the melting point), but no one ever succeeded in reproducing Violle's results, and it is now recognized that this standard is far from being exactly reproducible, because the radiation from platinum is so susceptible to the influence of surface conditions and surroundings. In practice Violle's determination of the unit was applied by using the Carcel lamp with the value which he assigned to it, and until recently this lamp has been retained as a reference standard. A law passed in 1919, however, while still referring to the Violle standard, specifically says that the unit, the Bougie Décimale, is represented practically and in a permanent manner by means of incandescent electric lamps deposited in the Conservatoire Nationale des Arts et Métiers. In Great Britain the candle was superseded by the Harcourt 10-candle pentane lamp, but it is difficult to reproduce such lamps exactly, and the accepted standard is not the pentane lamp in general, but a particular lamp of this kind at the National Physical Laboratory. Moreover, the standards actually used at the National Physical Laboratory are electric incandescent

lamps. These lamps were originally calibrated by comparison with the pentane lamp mentioned, but published records indicate that only two series of such comparisons have been made, so that in effect the unit is maintained by the electric standards. In Germany the Hefner amyl-acetate lamp is presumably still the nominally recognized standard.

In addition to the uncertainties inherent in all these flame standards all of them show systematic variations resulting from atmospheric conditions. Consequently in every case the actual light output of the flame standards under average conditions has been determined by means of incandescent electric lamps, which are free from these effects. The electric lamps have proved so much more reliable and convenient than the flames that there has been a marked tendency to use them as the real standards, comparisons with the flames being rarely made. In fact the international agreement mentioned has been obtained and is maintained by means of comparisons between electric standards initiated by the Bureau of Standards after several attempts made in Europe to reach agreement by direct comparison of flame standards had failed.

This procedure is in part analogous to that followed in the case of the international ohm, which is maintained by means of wire resistance standards whose value is derived from mercury ohms set up at infrequent intervals, but there is the very important difference that there exists no reproducible primary standard of light analogous to the mercury ohm. In the adoption of the unit of candlepower in the United States this difficulty was faced, and it was decided not to adopt any of the existing nominal primary standards, but to base all values on a large group of electric incandescent standards pending agreement on a more satisfactory primary standard.

Some sixteen years have passed since this decision was made. During that time extensive experimental studies of the various flame standards have been made at the Bureau, and the net result of these investigations has been a confirmation of the wisdom of the course taken. Instead of the flame lamps being taken as a fundamental basis for the calibration of the electric standards, this relation is reversed, and the flames are used only as working standards for less precise measurements where facilities are not available for operating electric standards.

For practical purposes the electric standards are highly satisfactory, and the probability of any important drift in the value of the unit maintained by them is almost negligible. Nevertheless it must be

admitted that such a drift is possible. Differences between the various national laboratories may develop and a common primary standard for reference would be highly desirable. Tradition and national pride make it difficult for any country to give up its old standards and especially so as to adopt those of some other nation, but so far as the United States is concerned the field is entirely open, and internationally the time appears favorable for the consideration of new proposals in this field.

In order to receive serious consideration, however, any proposed primary standard of light must be capable of reproducing values with an accuracy better than one per cent, and one-tenth per cent should be within the range of its possibilities. To attain such accuracy will require the most careful application of all our knowledge of radiating bodies, but all recent discussion trends toward defining the unit of light in terms of the established properties of radiators, rather than of trying to devise other special standards of candlepower. The properties of the complete radiator, or black body, are well established both in theory and in experiment, and this line of development appears to hold out most hope for the attainment of a light source exactly reproducible from specifications. The very rapid variation of brightness with change in temperature, which makes optical pyrometry practicable and precise, is, however, a serious and fundamental difficulty in using the black body as a standard of candlepower. At the temperatures which would be most suitable, a change of 1 per cent in temperature makes about 12 per cent change in brightness. Consequently the temperature must be known to about 2 degrees or one-tenth per cent in order to determine the light output to one per cent. The attainment of such accuracy does not, however, appear impossible.

Two comparatively recent experimental investigations bearing directly on the possible establishment of the black body as a primary standard of candlepower have been reported. One of these made by Hyde, Forsythe, and Cady in the Nela Research Laboratory was a determination of the brightness of a carbon-tube furnace over a considerable range of temperatures, including the temperature at which the light from the furnace matched in color that given by the carbon incandescent electric lamps which are now our basic candlepower standards. This temperature was found to be about 2077 degrees K., and at 2077 degrees the brightness was determined as 70.2 candles per square centimeter. This value has therefore been proposed tentatively as an absolute standard of light.

The value of such a specification, however, is obviously dependent on two things which are very difficult to ensure. The first is the establishment of a temperature scale which is reliable and reproducible within 2 degrees or better at these high temperatures, and the second the construction of a furnace which approaches closely enough to uniform black body conditions to make sure that the part of the furnace from which light is emitted is really at the temperature assigned to it.

Now these high temperature scales are based on and checked by melting points of pure metals. Years ago Waidner and Burgess suggested that Violle's idea of using platinum at the melting point for a light standard might be made practicable if the platinum were not used as a free radiating surface, but merely served to control the temperature of a black body. Nearly everybody has recognized the essential soundness of this proposal, but for various reasons it has only recently been tried out experimentally. One of the obvious difficulties was the cost of the platinum which would be necessary if measurements were to be made on a black body radiator of anything like the ordinary kind. A few years ago H. E. Ives conceived the idea of getting the desired effect with a moderate quantity of platinum by using for the black body a hollow platinum wedge electrically heated to the melting point. Observations were made on four wedges with very consistent results, the average brightness found being 58.35 candles per square centimeter, with an extreme range of one-half per cent. Other data obtained in the same investigation were, however, inconsistent, and extensive study would be required to determine the effect of a number of conditions which may affect the results. Although the wedge forms a satisfactory radiator for pyrometric work, there is serious doubt whether it can be satisfactory for the very exact approach to black body conditions required to give reliable candlepower values.

Realizing the difficulties of proving that the wedge form conformed closely enough to complete black body conditions, Ives has more recently studied the possibilities of a hollow cylinder of platinum in which the conditions can be more definitely established. The results of this investigation were reported to the Franklin Institute a few weeks ago, but have not been published.

The preliminary values reported show a highly satisfactory degree of consistency among the observations. Comparison of Ives' results with those of Hyde, Forsythe, and Cady will be somewhat uncertain because it must depend on the temperature to be assigned as the

melting point of platinum on the Nela Research Laboratory scale. It would appear, however, that agreement of the photometric results could be obtained by assigning such a temperature well within the range of the present uncertainty of the true melting point.

While more refinement will be necessary before the practical standards of candlepower can be based on black body measurements, these two investigations seem to justify hope that this can eventually be done so that we shall have a really reproducible primary standard depending only on the melting point of platinum and the complete radiator, and otherwise independent of the properties of materials.

Flux Standards.—Before passing from the subject of standards it may be well to revert to the question of measurement of flux. All the standards mentioned serve to furnish values only of candlepower or brightness, whereas now-a-days all lamps are preferably rated in lumens, so that some sort of transformation of values is necessary. This is accomplished in two steps. Standards of flux (or of mean spherical candlepower) are established by measuring successively the candlepowers of electric lamps at various angles from the axis of the lamps. The total flux can then be calculated, and these lamps are then used as standards in an integrating sphere for the measurement of other lamps.

A full discussion of the theory of the sphere as actually used is hardly practicable here, but the basic principle is exceedingly simple. The interior of the sphere is supposed to have a perfectly diffusing surface; every element of this surface when illuminated reflects light of an intensity which is at a maximum normal to the surface and falls off in proportion to the cosine of the angle as one departs from the normal. If we consider where this light falls on another element of the surface, we find by a simple calculation that each element of the surface illuminates every other one equally. The result is that, if we do not count in the original light which fell on the surface to make it luminous the illumination of all parts of the interior is the same. Furthermore if the wall is uniform, the illumination of all parts will be the same no matter how the original light was distributed. If we therefore put a lamp in the sphere, add a small screen to shade a spot from the lamp, and then measure the brightness of that spot, we have a measure of the total flux from the lamp.

In actual practice the theoretical requirements of the sphere can be approximated so closely that the systematic errors can be kept below one per cent except in extreme conditions. All lamp factories and important laboratories now use spheres, and a large proportion of the standard lamps called for are flux standards.

THE FUNDAMENTAL QUESTION OF LIGHT EVALUATION

Limited Significance of Measurements.—It may be considered that we have for practical purposes fairly complete and satisfactory paraphernalia for light measurements. It should be noted, however, that so far nothing has been said about the properties of the eye which was, by the definition of light, made the arbiter as to what is "light" and what is not. Most of the measurements that have been mentioned might be made by a bolometer or other radiometer as well as by the eye if it were found convenient to do so, since it has been tacitly assumed that the lights to be compared would be alike in quality. So far, therefore, we have dealt with definite physical relations wherein the attainment of accurate values is a straightforward problem of laboratory technique. Personal and instrumental errors of course, come in, but in each case there is a definite and correct answer to the problem, and this correct result can be approximated more and more closely in proportion to the skill and patience shown by the observers. Unfortunately, however, this condition does not apply to many of the so-called "measurements" of light which we have to make.

I began by defining light as radiant energy evaluated in proportion to its ability to stimulate the sense of sight, but we must ask what "sight" means when we wish to compare lights that differ distinctly in spectral composition. Does it mean ability to see fine details distinctly, to distinguish differences of light and shade, or does it mean the ability to take in a general perception of our surroundings? Of course, sight means all of these combined, but unfortunately for our "measurements" of light, when we have to deal with lights of different quality these different functions of sight assign different relative values to them, and in order to get any start at all on quantitative data we shall have to say more exactly what we mean by the sense of sight.

So long as the lights dealt with are of about the same color it is easy to find the relation between them, and it has been generally agreed that measurements shall be made by some device which obtains an equality of brightness on two white surfaces side by side. As a natural development the same procedure has commonly been used for lights differing in color, and following this custom we may assume "sense of sight" for the present purpose to mean "sense of brightness." But when we have to deal with lights of considerable color difference it becomes doubtful what is meant by equal "brightness." The

relative subjective brightness of two different colored surfaces may vary considerably according to the part of the retina the light falls on, for most parts of it the relative brightness depends more or less on the absolute brightness, and in general it is different for different people.

As a convenient illustration of these variations a piece of blue paper on a red background may look brighter than the red at low illuminations, become equally bright at somewhat higher illumination and decidedly darker at a still higher level. The transition point depends on the size of the samples used, and different persons will place it at quite different illuminations. Moreover, when the illumination is fairly high and the color of the surfaces distinctly different, most persons find it almost impossible to judge when equal brightness is attained.

The question is then how shall we determine when colored lights are equally bright, or how otherwise shall we meet the need of describing these lights in definite terms. To begin with, it should be recognized that the thing we want to define and measure has no real and definite existence, but must be more or less arbitrarily established. The problem is not merely one of finding a value for a quantity which varies with other conditions. If one unit of radiant energy gives rise to a certain sensation, we must remember not merely that ten times as much energy does not produce ten times the original sensation, but that the multiplying factor may vary appreciably with conditions. An analogy may make the troubles more evident. It is sometimes necessary to compare a length standard of brass with one of platinum. In order to have a definite ratio they must, of course, both be kept at specified temperatures. Now let us imagine three kinds of difficulties to arise; first, when the meter of brass has been carefully adjusted to equal the meter of platinum, a measurement by centimeters indicates that one bar is longer than the other; second, if we change the size of the microscope field used for observations one bar expands and the other contracts; third, each individual observer when he looks through the microscopes causes a temporary differential shrinkage or expansion of the two bars, the amount of this differential being more or less characteristic of the individual, but varying somewhat from day to day. Now if all these troubles really arose I think we would be inclined to say that comparing brass meters with platinum was a useless undertaking. Yet when we make such a measurement as the direct comparison of a normal tungsten filament lamp with a carbon lamp there are systematic difficulties closely analogous

to all three mentioned, with the added one that for many would-be observers there is great difficulty in deciding on any values at all. Moreover the magnitude of the effects concerned is not, in general, negligible in comparison with the accuracy expected in practical measurements.

I think I have enlarged on this point sufficiently to make clear what I wish to emphasize, namely, that the ratio of the subjective brightness of two lights of different color is not a definite and single-valued quantity, but depends upon the conditions of observation as well as upon the characteristics of the individual observer's eye. In particular, in order to make values definite it is necessary to specify more or less precisely the size and brightness of the photometric field, which determine the parts of the retina used and its level of adaptation. It is also necessary to include observations by a sufficient number of individuals to approximate the results which would be obtained by an imaginary average, or normal, observer. It is obvious also that relative values determined under these limited conditions must not be applied indiscriminately. For example, a comparison of two lights under the standard conditions may not show at all accurately their relative effectiveness at the low illuminations often used on highways, nor does a measurement of brightness necessarily show accurately the relative merits for work on fine details.

Nevertheless it is useful and almost necessary to have some means of describing in a quantitative and comparable way the different kinds of light we have occasion to use. We actually are measuring them continually and I shall try to outline briefly the present status of methods for such measurements.

Direct Equality-of-Brightness Observations.—The earlier illuminants were nearly alike in color. Consequently the complications just described did not become practically important until recent years. By the time these problems arose, excellent instruments had been developed and photometric laboratory apparatus was more or less standardized throughout the world. The natural course, therefore, was to use these instruments and methods and to do the best one could with them in measuring the newer illuminants. The rapid development in succession of metallized carbon, tantalum, vacuum tungsten and gas-filled tungsten lamps has accentuated the difficulties and has made them affect the most common types of commercial photometric work. Other developments, such as mercury vapor lamps, nitrogen discharge tubes, and neon lamps, as well as special filters and glasses to give color effects, have created still more serious difficulties for the photometric laboratory.

Because of the difficulty of obtaining reliable and reproducible results, the practice early developed of preserving values on certain steps by the calibration of color filters, such as blue glasses, which, interposed on one side of the photometer, would equalize the color of two different lamps. Another procedure has been to make many observations to determine values for secondary or derived standards of the different kinds of lamps to be measured.

The extreme case of the latter procedure is perhaps that followed by the British National Physical Laboratory where six sets of electric standards were carefully calibrated by equality-of-brightness observations covering the range from the color of the pentane flame standard up to a low-efficiency vacuum tungsten lamp. This was very carefully done by a number of experienced observers and affords a good example of the essential uncertainty of the procedure. The divergence between different observers, of course, increased on the successive steps, and a difference of nearly 3 per cent in the final values developed between extreme observers. Measurements were also made in which the same observers jumped directly from the lowest to the highest efficiency within this range. The average candlepower of the higher efficiency lamps by the two methods agreed within 0.3 per cent, but it is significant that in the direct single step with larger color difference, the observers were grouped more closely than on the final results obtained step by step. The total range of the results and the average deviation from the mean in the direct measurement are only six-tenths as great as in the step-by-step or cascade measurements. When it is considered that the range of efficiencies covered is only from 2 to 6.5 lumens per watt, whereas present day gas-filled tungsten lamps fall considerable above 20 lumens per watt on the same scale, it is evident that the results are not satisfactory for precise measurements in which an accuracy better than 1 per cent is expected.

At the Bureau of Standards a somewhat different course was followed in that instead of establishing different sets of standards for different efficiencies, values for a group of tungsten lamps were determined over a considerable range of efficiencies and the variation expressed in curves and equations. Furthermore, this work developed the fact that for all the ordinary sizes of vacuum tungsten lamps the same equations would apply. In other words, the variation in candlepower and efficiency as a vacuum tungsten lamp is changed in voltage is a definite property, presumably because it represents in a fairly simple way the properties of radiating tungsten at given

temperatures in a vacuum. These equations, known as the Middlekauff-Skogland equations, have been very useful and still constitute the best established procedure for determining relative values for vacuum tungsten lamps at various efficiencies. Moreover, the experience gained at the Bureau since these equations were established indicates that the values were very fortunately chosen. They apparently agree well with the National Physical Laboratory results over the range where they overlap, and the values have been rather closely checked by successive groups of observers at the Bureau during the undesirably rapid change of personnel which we have suffered during the last few years. It should be emphasized, however, that groups of observers of at least equal experience in other laboratories have not agreed so well with these results.

Some years ago very careful comparative measurements on lamps and glasses representing the step from carbon lamps to tungsten were made by groups of five or six observers in each of the three laboratories in the country best fitted for this work. Measurements made a number of months apart indicated that each laboratory adhered very closely to its average result, the consistency of performance in this respect being within one-quarter of one per cent. However, the difference between two of the laboratories became as large as 1.9 per cent, although the range covered was only that from carbon lamps to vacuum tungsten and did not approach the color of gas-filled lamps. The Bureau of Standards was at one extreme in the results obtained, but other data have been in general more consistent with the Bureau's own measurements in this intercomparison, and consequently these values as represented in the Middlekauff-Skogland curves have been retained. The rather imperfect agreement obtained in the intercomparisons has been accepted as a practical corroboration of these values, but again it is somewhat disturbing to have differences of the order of 2 per cent in checking values which are supposed to be maintained to a fraction of 1 per cent.

The result of such comparisons as have been referred to has been to establish agreement on more or less arbitrary values for standards of successively higher and higher temperature and efficiency, which, when once established, can be maintained as practically independent standards for future use. In fact in the case of the National Physical Laboratory it is definitely stated that the values of the higher efficiency standards are "assigned to them once for all." Such multiplication of standards, or determination of curves, while serving to meet the more urgent commercial needs, is limited in its application.

There is always doubt as to the certainty with which the values can be reestablished by reference to the fundamental standards even though the color differences involved are the relatively small ones represented by incandescent lamps of different efficiencies. Furthermore, this method is, of course, not at all applicable to color differences which can not be reached step by step or for which there is no suitable secondary reference standard available.

Flicker Photometry.—Various methods for meeting or avoiding these difficulties have been proposed. The only direct method which has given any evidence of practicability is the use of the flicker photometer. This type of photometer differs from the ordinary one in that it presents the two photometric surfaces to view alternately in the same place instead of simultaneously side by side. One of the peculiarities of vision is the fact that the two colored surfaces can be interchanged at such a rate that the disturbing color differences are no longer seen, although differences of brightness still show in the form of a perceptible flickering of the light in the field. Consequently a speed of alternation can be chosen to get rid of the color sense, and then a setting for equal brightness can be made by finding the point at which the flicker disappears or reaches a minimum. Whether the "brightness" thus found is exactly the same thing as that found by the ordinary photometer is a disputed question. As we have already seen, however, brightness must be rather arbitrarily defined in either case, and it appears that a suitable choice of conditions will give a very close agreement between the two methods.

The results obtained by the flicker photometer are not free from variation with conditions such as field size, absolute brightness, and individual characteristics of the observer. The advantages of the instrument are simply that definite results can be obtained on any color difference by any observer and that the results at various times and on related color differences are far more consistent than when measurements are made by the ordinary photometer. This consistency makes it possible to establish the characteristics of an observer and to predict rather accurately what results he will obtain in comparison with an average observer. As an example of the possibilities in this kind of procedure, the Bureau of Standards has for a considerable time made use of a simple test originally due to Ives which indicates the relative values an observer may be expected to obtain when comparing lights of certain types. The test measurement is the determination of the transmission of two solutions, one of which transmits the blue end of the spectrum while the other transmits the yellow end.

The densities of the two solutions are so chosen that for the average observer they transmit equal percentages of light from the standard carbon lamp. In general, different observers find different values for the transmission of each of these solutions under standard conditions, and it is convenient to use the ratio of the two transmissions as a rough indication of the characteristics of the observer. The use of such tests is not merely a matter of finding "normal" and "abnormal" observers, for we find that the characteristics of observers extend over a considerable range with a distribution roughly approximating that represented by the ordinary "curve of errors." It should be noted that this distribution does not represent error of measurement since each observer will repeat his values with a certainty represented by a very small part of the range of distribution. In other words, the curve represents the real distribution of individual characteristics, not the errors in determining those characteristics.

This characteristic ratio for a given observer is closely correlated with the results which the observer will obtain in comparing the light emitted by radiators at different temperatures, such as lamps of different efficiency. It is therefore possible by the use of these test measurements to reduce the results obtained by any small group of observers to a normal value with a considerable degree of certainty. An illustration of such correction is shown in Table II which represents an actual case where five observers determined a ratio equivalent in color to the step from vacuum tungsten to gas-filled standards.

It happens that at the time this work was undertaken the group of observers available showed a wide variation in test ratios as given in column 2. Consequently their deviations from the average were very large, as shown in column 4. Nevertheless when corrected they gave an agreement which is practically perfect for such work, the average deviation of the individual observers being less than one-tenth of one per cent from the mean. In this particular case it happens that the observers are so distributed that their uncorrected mean is equally good, but this condition can not be depended upon. Ordinarily a group of observers will show much less scattering in their characteristics so that the individual corrections will be less important than they were here, but one can not depend upon a small group being symmetrically placed with reference to the mean as this one was.

It should perhaps be noted that for relatively small color differences the flicker photometer is not as precise as the ordinary form. For the moderate color differences represented by the step from carbon

to tungsten lamps, the advantage of the flicker lies not so much in greater precision as in the certainty that the results obtained in a particular case are consistent with those obtained at other times and that they will agree with results made by similar methods by a different group or a different laboratory. In other words, the variations shown by the flicker method are scattered about a definite point in a purely accidental fashion, whereas the measurements by equality-of-brightness by an experienced observer may be just as consistent among themselves and yet be greatly influenced by a permanent prejudice.

The test-ratio scheme here illustrated is of course of limited use. Nevertheless it makes possible a decided improvement in the certainty of the measurements which are now of most practical importance, and the general principle of test measurements and of establishing normal values which will be accurately reproducible is

TABLE II.—Correction of Individual Observers' Results to Normal

Color difference equivalent to step from 9.3 to 18 lumens per watt

OBSERVER NUMBER	TEST RATIO	DEVIATION FROM NORMAL	PHOTOMETER RATIO	
			Observed	Corrected
1	0.900	−0.087	0.2625	0.2648
2	0.909	−0.079	25	46
3	0.981	−0.006	47	49
4	1.024	+0.037	59	49
5	1.110	+0.123	86	54
Mean..........	0.985		0.2648	0.2649

applicable to all sorts of measurements. It must be admitted, however, that the principle of the flicker photometer appears to be much farther removed from the actual conditions under which light is used than the simpler photometers are. The general adoption of this method of comparison is therefore doubtful.

Visibility Curves.—In discussing the definition of light it was suggested that we might consider each element of radiant energy to be tagged with a coefficient representing its relative visual effect. Further consideration has shown that the value of this coefficient is somewhat indefinite. Nevertheless if we agree on definite conditions and methods of observation, an average value can be given for this coefficient for each wave-length. A complete solution of the problem of photometry must include the determination of these relative visual coefficients, and when they are established all other comparisons might be based on them. It is, however, no simple matter to establish

satisfactory values for these coefficients or for the "visibility" curve which represents them. Fortunately it is only a few weeks since Dr. Gibson presented to the Society the general results of the most recent work on visibility curves, and consequently I shall not burden you with details of the methods of determining them. While Gibson and Tyndall's curves were determined by equality-of-brightness settings, following a step-by-step method used earlier by Hyde, Forsythe, and Cady, the greater number of such determinations have been made by use of the flicker principle. The most extensive investigation of this kind was carried out by Dr. Coblentz a few years ago, and was likewise reported here.

If one plots together the curves obtained for individual observers in any of these investigations the result is a diffuse band representing the scattering of the curves of different individuals. While there is a general similarity in the curves of all observers, individual differences are such as to represent a very large percentage variation. Here, as in the case of the simpler test-solution measurements already mentioned, any classification of observers as "normal" or "abnormal" must be arbitrary, since a complete gradation is found between the most extreme types of curves. The choice of a general average or "normal" curve is therefore difficult.

The results of Gibson and Tyndall and of Hyde, Forsythe, and Cady, both made by equality-of-brightness methods, show an agreement which is really remarkable when the difficulties of the investigation are considered. In fact it is quite possible that the differences found are to be explained by the fact that observing fields of different size and form were used in the two laboratories.

Gibson's comparisons of his own results with those of Coblentz also show a fairly close agreement, but apparently indicate a real difference between the results of the two methods. There are two conditions, however, which make this conclusion somewhat uncertain. These are that the energy values used were determined in entirely different ways, and that several years elapsed between the two investigations so that the observers common to both may have changed their characteristics in the meantime. The conditions of field size and brightness used were also slightly different.

My opinion is that most of the earlier determinations of visibility may now be given little weight, and that the most reasonable method of establishing experimentally a reliable normal, or average, curve is to carry out such measurements as are necessary to answer the unsettled questions with regard to the differences between the Coblentz

flicker data and the results of the other determinations mentioned. All of these were carried out with such care and thoroughness that they should serve to establish a standard curve which would approximate as closely as can be expected to the characteristics of the hypothetical average observer.

When such a standard visibility curve is established, the total light value of radiant energy of any quality for which spectral distribution curves can be obtained will become merely a matter of calculation or of graphic determination. It is evident, however, that these visibility curves are subject to all the limitations of brightness measurements. Using them, consequently, does not solve all our difficulties. Moreover, the experimental difficulties in obtaining reliable spectral distribution curves are considerable, and the aggregate errors of calculated values may often exceed the uncertainty in the direct comparison by simpler methods. Values calculated from spectral measurements and visibility curves are in fact hardly capable of an accuracy such as is most commonly desired in photometric results.

In this connection mention should be made of two interesting possibilities in the way of more reliable comparisons by means of visibility curves, both of which have been described in recent years before the Society. One is the combination of Nicol prisms and quartz plates, devised by Priest, which constitutes a color filter whose spectral transmission curve is adjustable over considerable limits and can be calculated with a high degree of certainty. These calculations as expressed in terms of light must, of course, depend on the visibility curve, but having a standard visibility curve, the results obtained by this device should be reliable.

The other possibility is that of a physical photometer consisting of an instrument for measuring radiant energy, combined with a filter which in effect adjusts the spectral sensibility of the radiometer to make it correspond to that of the standard curve adopted as representing the sensibility of the eye. The refinement of laboratory technique required to make accurate measurements of radiant energy is such that this method of measurement does not appear likely to find very extensive application, but its possibilities may be worth further investigation.

CONCLUSION

While applications of the visibility curve will undoubtedly constitute a valuable supplement to more direct measurements, the situation will never be entirely satisfactory unless the values thus calcu-

lated can be checked by more direct measurements. It is, therefore, highly desirable that when a standard visibility curve is adopted it be made to fulfill this condition. In order to do so it may possibly be necessary to adjust the experimentally determined visibility curve to a slight extent. Whether this will be necessary or not can only be determined by comparing results calculated from various visibility curves with those established by direct measurement. As has been repeatedly indicated above, results obtained by all methods depend to some extent on conditions which have to be chosen more or less arbitrarily. It is to be hoped that agreement can be reached on the specification of conditions such that consistent results can be obtained whether one uses the equality-of-brightness photometer, the flicker photometer, or spectral measurements in combination with a visibility curve. There appears to be no doubt that conditions can be so specified as to bring about this condition so far as comparison of incandescent radiators at different temperatures is concerned. For instance, if the standard visibility curve be adjusted to make it agree with the usual equality-of-brightness photometer as now used for these measurements, flicker values can readily be brought into agreement by correcting them to a "normal" slightly different from the results which that instrument would give when used by the average observer. There would appear to be some justification for adopting as one of the basic conditions the use of the small central portion of the retina which is actually used in observation of details. If this were done it is probable that all three of the photometric methods mentioned could be brought into very close agreement.

If such a solution for the fundamental problem of comparison of brightness can be obtained, and the black body is made to furnish a standard reference source, our system of assigning values to lights of every kind will probably be in as satisfactory a condition as the intrinsic difficulties of the subject will ever permit.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

874TH MEETING

The 874th meeting was held in the Cosmos Club Auditorium on Saturday, December 16, 1922. It was called to order at 8:20 P.M. by President WHITE with 33 persons present.

The minutes of the 872d meeting were read and approved.

By invitation, Mr. A. H. BENNETT addressed the Society on *The aberrations of anastigmatic photographic lenses.* The address was illustrated by lantern slides, and was discussed by Messrs. WHITE, HEYL, WILLIAMSON, LAMBERT, PAWLING, L. H. ADAMS, and PRIEST.

Author's Abstract: In the design of photographic lenses, two requirements are dealt with which are not often found combined in other types of optical design.

In the first place, the photographic lens must have a wide angular field of view, which commonly ranges from 40° to 60°. In addition, a large relative aperture is necessary in order that the lens should have sufficient rapidity. These two requirements prohibit an extremely fine correction for the aberrations.

The definitions, general effects on the defining power of the lens, and suitable method of plotting graphs of the aberrrations, together with methods of measurement were given. Average values for the magnitudes of the different aberrations as found from a series of measurements on twenty-five (25) lenses made by eight manufacturers, were presented.

Improvement in this type of lens by the employment of aspherical surfaces, which are more favorable for the correction of the aberrations, will probably result in a great increase in relative aperture, without increasing the aberrations beyond their present values.

Mr. S. P. FERGUSSON and Mr. R. N. COVERT presented a paper on *The measurement of the wind*, which was read by Mr. FERGUSSON. The address was illustrated by lantern slides, and various types of anemometers were exhibited. The paper was discussed by Messrs. WHITE, PRIEST, L. J. BRIGGS, HECK, and HARPER.

Author's Abstract: A review of the progress of anemometry during the past century shows very clearly that much of the confusion or discordance in data of the direction and velocity of the wind is due to the absence of definitions. It is not necessarily difficult to rate an anemometer with a precision satisfactory for most uses, but, if there is considerable difference in the frequency of readings the indications of two similar instruments may disagree as much as 50 per cent and both be correct. The cause of this is the extreme variability of the wind, of which the direct fluctuations may extend 50 per cent or more on either side of the average velocity prevailing during a period of time exceeding one minute; ten or more oscillations may occur in one second. The extreme range of mean velocity, or the movement of the wind during periods of five minutes or longer (published in current reports), extends from a calm to about 60 meters a second, the latter velocity occurring sometimes at exposed stations. At most inland stations, however, the extreme velocity of gales seldom exceeds 30 meters a second. Another characteristic of the wind, of considerable importance in the design of ane-

mometers or structures that must resist high winds, is the small extent of gusts or extreme variations in velocity; momentary differences of 30 per cent have been observed between well-exposed anemometers less than two meters apart, while long-period variations are usually nearly synchronous over areas whose width or extent may exceed 100 meters. Obviously, therefore, two standards are needed, one for average velocities and one for gustiness, the measurement of which can best be accomplished by the use of separate instruments of appropriate sensitiveness.

The factors or constants of most anemometers in general use were determined with fair accuracy by means of whirling machines, at low and moderate velocities, about thirty years ago; but, only within the past few years has it been possible to rate an instrument at the high velocities sometimes attained by the natural wind. The modern wind-tunnel, designed particularly for experimental studies in aerodynamics, has proved to be a most excellent device for standardizing anemometers, as shown by the recent work of BRAZIER in France, PATTERSON in Canada, and that of the Weather Bureau. The Bureau of Standards, having kindly placed the wind-tunnels of its aerodynamical laboratory at the service of the Weather Bureau, the authors, beginning in March, 1922, have tested about thirty anemometers of various patterns, dimensions, and weights at velocities throughout the range of the natural wind, and at various angles of inclination. In August, 1922, fifteen of the same instruments were taken to Mount Washington, New Hampshire, for comparison in the high natural wind prevailing there in order to ascertain differences of behavior in steady and variable winds. The purpose of this work is to determine corrections for the present standard anemometer and to develop a new standard indicating true velocities, for routine and special uses. It is expected that this investigation will be completed during the coming year. The following preliminary results, subject to revision, are considered important:

Velocities indicated by the small Robinson anemometer in use in the United States are approximately 22 per cent too high. The factor determined in wind-tunnels appears to be more nearly constant than that previously ascertained by means of whirling machines.

The factors of many anemometers in use have been determined at velocities throughout the range of the natural wind.

The differences between instruments in the wind-tunnels and in the natural wind appear to be small; not much larger than the normal differences between anemometers of the same kind.

The differences between average velocities indicated by light and heavy anemometers compared on Mount Washington are small; none larger than 3 per cent have been found, so far, and the heavy Robinson instruments tend to under-register. This experiment may require repetition since the results stated are not strictly in accord with earlier work.

The rate of an anemometer increases as the axis is inclined, reaching a maximum with an inclination of about 30°. This was discovered by BRAZIER and confirmed by the experiments at the Bureau of Standards.

The three-cup type of ROBINSON anemometer suggested by PATTERSON appears to be more satisfactory than the usual four-cup instrument. Its factor is more nearly constant and, since but one cup at a time is sheltered, three cups are practically as effective as four of the same size.

It is hoped that these independent investigations in anemometry will result in the adoption of the standards of velocity and methods of measurement referred to and the determination of factors whereby the rate of any anemometer can be ascertained when its dimensions and weight are known.

Dr. L. J. BRIGGS presented an informal communication on *Direct measurement of air speed in wind-tunnels.*

Author's Abstract: At the request of the National Advisory Committee for Aeronautics, the Aerodynamical Physics Section of the Bureau of Standards has made some direct determinations of the air speed in a wind-tunnel for comparison with pitot-tube measurements of air speed.

The method employed was as follows:

A small parallel pencil of light from an arc source was so reflected that it traversed the tunnel three times at right-angles to the longitudinal axis of the tunnel and was finally focused upon a photographic film carried on the surface of a rapidly rotating drum. The distance between adjacent beams measured along the axis of the tunnel was approximately one meter.

Small balloons filled with hydrogen and weighted so as to have the same average density as the air-stream were carried through the tunnel with the air-stream. Each balloon eclipsed successively the three light-beams and the instant of the eclipse was indicated by a break in the trace on the photographic film. Timing lines, representing time intervals of one-thousandth of a second, were simultaneously recorded on the film with the aid of a 500 cycle tuning-fork operated by an electron-tube drive. By this means the time required for the balloon to travel from one light-beam to the next could be measured, which, in connection with the known distance between the light-beams, gave the data necessary to determine the air-speed. The pitot-tube pressure developed by the air-stream was also continuously recorded on the film with the aid of a diaphragm gauge equipped with a mirror. Preliminary measurements indicate that the mean of the speed determinations by the balloon method agrees with the air-speed measurement as determined by the standard pitot-tube to within two-tenths of one per cent.

Adjournment at 9:55 P.M. was followed by a social hour.

875TH MEETING

The 875th meeting was a joint meeting with the Washington Academy of Sciences in the Cosmos Club Auditorium on Thursday, December 21, 1922. The meeting was addressed by Dr. H. A. CLARK of the Taylor Instrument Company of Rochester, New York, on *The manufacture of thermometers.* The address was illustrated by lantern slides, and some specimens of thermometer tubing and of thermometers were exhibited. The paper was discussed by Messrs. HUMPHREYS, JONES, KADEL, and HAWKSWORTH. The meeting adjourned at 9:40 P.M.

876TH MEETING

The 876th meeting was held in the Cosmos Club Auditorium January 13, 1923. It was called to order at 8:30 P.M. by President WHITE, and 62 persons were in attendance.

The address of the evening was given by the retiring President, E. C. CRITTENDEN, on *The measurement of light.* The address was discussed by Messrs. PAWLING, L. H. ADAMS, HAWKSWORTH, WILLIAMSON, and MOHLER. It will be published in an early number of the Journal of the Washington Academy of Sciences.

Adjournment at 10 P.M. was followed by a social hour.

J. P. AULT, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The third paper of the series discussing the Quantum Theory was presented before the Physics Club, Bureau of Standards, by F. L. MOHLER, January 22, 1923. The subject was *The atomic structure of chemical elements.* An abstract by the author follows:

We assume that a chemical element of atomic number Z contains Z electrons each in an orbit determined by quantum conditions similar to those demonstrated experimentally for hydrogen and helium. A rigid mathemattical solution is impossible but in a heavy atom the inner X-ray orbits approximate hydrogen orbits around a charge Z. An analysis of X-ray spectra shows that all positions of equilibrium within the atom are occupied by electrons. There are one K, three L, five M, seven N, and five O levels known. The total quantum numbers are K_1, L_2, M_3, etc. The number of electrons within each orbit can be estimated and the ellipticity of orbits is known. There are as many shapes as allowed by the total quantum number. It is concluded that both in the formation of an atom and in the course of the periodic table groups K, L, M, etc., appear in the order of their quantum number and within each group it is the most elliptical orbit which appears first.

The space configuration must be symmetrical in a complete group and by non-mathematical reasoning we see that the rare gases mark stages in completion of groups and that chemical and physical properties of successive elements can be predicted in some detail from the scheme of atom building indicated by X-ray spectrum theory.

Dr. L. B. TUCKERMAN delivered the fourth lecture of the above series on January 29, 1923. His subject was *Continuity vs. discontinuity.*

Since the beginning of human thinking there have been two different ways of looking at the physical universe. From the one viewpoint the apparent discontinuities of physical phenomena are only singularities in an underlying continuous substratum. From the other viewpoint the apparent continuities of physical phenomena are only statistical averages over underlying discontinuities. Nearly twenty-five hundred years ago Zeno of Elea in his paradoxes pointed out the difficulties involved in both these conceptions.

After the introduction of the calculus as the basic mathematical tool of theoretical physics, the viewpoint of continuity grew to be the customary viewpoint of the physicist. The critical investigation into the mathematical idea of continuity by Bolzano, Weierstrass, Cantor, and others, together with the growth of the modern atomic theory in the hands of Dalton and his followers, the introduction of the electron by J. J. Thomson and finally the quantum by Planck, have rendered this viewpoint less satisfactory.

The development of a theory which shall weld these discontinuities into a coherent whole with the continuities of the older physics is a leading problem of physics today. It is too early to be certain in which direction this development will take place. It may be that the electron, the atom and the quantum will finally be interpreted in terms of an underlying continuity. On the other hand it may be (and the development of the Bohr atomic model seems to make this more probable) that our future picture of the physical world will be essentially discontinuous in all its elements.

The American Nature Association has published the first number of its new monthly periodical, "Nature Magazine." This publication provides accurate and readable information on outdoor subjects and presents the material in an entertaining fashion. All information can be obtained from the American Nature Association, 1214 Sixteenth Street, Washington, D. C. The editors are P. S. RIDSDALE and A. N. PACK.

The Maryland-Virginia-District of Columbia branch of the Mathematical Association of America held a semiannual meeting at the Bureau of Standards, December 9, 1922.

Dr. WILLIAM N. BERG has resigned his position as pathological chemist in the Pathological Division, Bureau of Animal Industry. He is now engaged in the manufacture of biological products at the Berg Biological Laboratory, Brooklyn, New York.

Mr. C. A. BRIGGS, associate physicist, Division of Weights and Measures, Bureau of Standards, has been transferred to the U. S. Department of Agriculture to the post of live stock weight supervisor in the Packers and Stockyards Administration.

Mr. M. R. CAMPBELL, geologist in charge of the coal section of the U. S. Geological Survey for the past 16 years, has been relieved of this duty at his own request that he may devote himself to the physiographic work of the Survey. Mr. W. TAYLOR THOM, JR., has been assigned to succeed Mr. Campbell in the coal work.

Dr. J. C. KARCHER of the Sound Laboratory, Bureau of Standards, has resigned to accept a position as technical adviser to the production manager of the Western Electric Company, Chicago, Illinois.

Mr. W. P. WOODRING has been granted leave of absence from the U. S. Geological Survey to do private work in South America.

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SOIL CHEMISTRY.—*Relations between the active acidity and lime-requirement of soils.* EDGAR T. WHERRY, U. S. Bureau of Chemistry.[1]

The lime-requirement, or amount of lime needed to bring a soil to a neutral reaction, is decidedly less easy to determine with certainty than is the active soil acidity, or hydrogen-ion concentration of the aqueous extract (also sometimes termed soluble, effective, or "true" acidity). If any numerical factor could be discovered connecting the two, it would be possible to carry out the simpler acidity determination, and then to calculate from it the lime-requirement. From an indirect comparison of the active acidity and the lime-requirement of the same soils Blair and Prince[2] have concluded that more or less correlation between these quantities does exist; but they did not work out the direct relations, nor do any other writers appear to have done so. The matter seems of sufficient importance, however, to justify further study of the available data.

In what follows, lime-requirement will be expressed in parts of calcium oxide per thousand; this being numerically identical with tons per acre, if that area is considered as offering for treatment two million pounds of soil (corresponding to a depth of approximately 6 inches).

Hydrogen-ion concentration will be stated in the form of specific acidity, which has been defined by the writer[3] as the acidity of a solu-

[1] Presented at the Birmingham meeting of the American Chemical Society, April, 1922. Contribution from the Laboratory of Crop Chemistry.

[2] Soil Sci., **9**: 253. 1920.

[3] Jour. Wash. Acad. Sci., **9**: 305. 1920.

tion, measured by hydrogen-ion, with reference to the hydrogen-ion content of water as a unit. To transpose P_H values (which are hydrogen-ion exponents, not concentrations, though often erroneously so termed) into specific acidities, subtract from 7, and raise 10 to the power thus indicated. The great advantage of this method of statement is the ease with which the relative acidities of different solutions can be appreciated. For example, the P_H values of two of the soil extracts discussed later are 5.8 and 5.5; which of these is the more acid, and how much more? Considerable calculation would be necessary in order to answer these questions. When these values are subtracted from 7 they give 1.2 and 1.5 respectively; and raising 10 to these powers with the aid of a table of logarithms yields the specific acidities 15.9 and 31.6. It then takes but a glance to see that the second solution is practically twice as acid as the first. The use of this method is recommended to writers who desire to enable their readers to appreciate relative values of acidity with a minimum of effort.

RELATIONS TO BE EXPECTED

Is any correlation between specific acidity and lime-requirement to be expected? Let us consider what these two quantities represent. The writer's views as to their significance have already been published in another connection[4] but they would seem to require re-statement here in a somewhat different form. In the determination of lime-requirement, lime water is added to the soil until the mixture shows a neutral or somewhat alkaline reaction. The calcium hydroxide is used up in decomposing any aluminium or iron salts present; and in neutralizing soluble acids, (the hydrogen-ion of which is the source of specific acidity) insoluble acids or acid salts, and any hydrogen-ion which may exist adsorbed on the soil colloids,[5] (the place of which may then be taken by calcium-ion).

As decomposable aluminium or iron salts, (such as the chlorides, sulfates or citrates) or of insoluble acids (e.g. dihydroxystearic) have never been demonstrated to be present in normal soils in more than minute amounts, the lime used up by them must be inconsiderable. The amount of lime needed to neutralize the soluble acid represented by a specific acidity of even 1000 (P_H 4) has been repeatedly

[4] Ecology, 1: 160. 1920. Especially pages 167–170.

[5] It is now generally believed that the source of the electric charge on colloids lies in adsorbed ions, especially H^+ and OH^-. This matter is fully treated in modern books on colloid chemistry, and need not be discussed further here.

found to be, as would be expected, quite negligible (about lime-requirement 0.002). The conclusion seems necessary, therefore, that the bulk of the lime taken up by a soil goes to neutralize hydrogen-ion adsorbed on the colloids; or, in other words, the lime requirement is essentially a measure of the amount of adsorbed hydrogen-ion present in a given soil.

The ratio between adsorbed hydrogen-ion (lime-requirement) and soluble hydrogen-ion (specific acidity) accordingly depends on the quantity and character of the colloid matter present. If several soils contain approximately the same amount of essentially identical kinds of colloid, then this ratio should be the same for all of them; a correlation between specific acidity and lime-requirement could be said to exist, and, provided the ratio has been determined in one instance, the lime-requirement could be calculated from observed values of specific acidity for this whole series of soils.

Data on gravelly loam soils.—All four soils discussed by Blair and Prince in the paper cited were considered to belong to the same soil type, Sassafras gravelly loam. To ascertain whether the ratio between specific acidity and lime-requirement is the same for all of them, these two quantities should be compared with one another directly. To this end, specific acidity values have been calculated from the P_H by the procedure above given, and lime-requirement values in tons have been obtained by dividing the number of pounds of CaO by 2000. The ratio between these two values may be simply and conveniently expressed in the form of a correlation coefficient, appropriately designated by the initial letter of the word colloid, C; this is the factor by which specific acidity (S.A.) must be multiplied to obtain lime-requirement (L.R.), that is, L.R. = C × (S.A. − 1). In this connection it should be noted that since the value of the specific acidity at the neutral point is 1, not zero, 1 is subtracted from S.A. in all calculations. It may also be remarked that the writer fully realizes that the uncertainty of measurements of P_H and especially of L.R. does not justify placing much dependence on the values of C beyond the second decimal place.

The specific acidity of these soils was found to range from 2.0 to 39.8, the lime-requirement from 0.05 to 0.8, and C from 0.010 to 0.200. The lower values of C represent untreated soils, the higher, those treated with lime. This is interesting from the theoretical standpoint, for it means that the ratio between soluble and adsorbed hydrogen-ion, and accordingly the character of the soil colloids, varies widely,

even among soils of similar aspect. But it indicates at the same time that it is impracticable to calculate lime-requirement from specific acidity without knowing exactly what soil is under consideration in each case.

Data on cranberry bog soils.—It now seemed desirable to ascertain whether other types of soils would yield results similar to the foregoing; and certain of the data presented by Joffe[6] were used for this purpose. This author plotted active acidity against lime-requirement in some cases, but as he used exponential values for the former, his correlations are not directly comparable with those of the present paper. On recalculating his data, the specific acidity was found to range from 1 to 1259, the lime-requirement from 0.1 to 7.5 and C from 0.004 to 0.200. There is a decrease in C with depth in the soil at a given spot. The relations thus correspond to those shown in the gravelly loam soils.

Data on a silt loam soil.—To obtain still further information upon the way in which the features in question vary from one soil to another, some data on an Ohio silt loam, published by Knight,[7] were used. (In this connection the writer wishes to state that he does not agree at all with the majority of Knight's conclusions.) The specific acidity observed ranged from 100 to 1140, the lime-requirement from 0.9 to 2.2, and C from 0.0015 to 0.0091. As in the other soils, the range in C is wide; but in this series of results it is brought out with special clearness that liming results in a marked increase in the value of C, although the effect varies to some extent with the differently fertilized soils, evidently because of the different ways in which the lime reacts with the compounds present.

Classification of soils on the basis of C.—The values of the correlation coefficient C for the whole series of soils above considered are collected in Table 1. They are arranged in a number of "classes," the typical value for each of which is made for convenience about twice as great as for the preceding one.[8] There are, of course, all gradations between these classes. It is evident that only if the class into which a given soil falls could be determined by some simple procedure, would it be practicable to obtain its lime-requirement from its specific acidity.

[6] Soil Sci., **9**: 261. 1920.

[7] Journal Ind. Eng. Chem., **12**: 559. 1920.

[8] In order to bring the values close to numerals the relationship of which is obvious, the multiple actually used is $\sqrt[3]{10}$ or 2.154. . . The rounded-off numbers obtained thereby, in all decimal places, are 1, 2 and 5.

TABLE 1—SUMMARY OF VALUES OF COEFFICIENT C [L. R. = C × (S. A. − 1).]

SOILS STUDIED	NO.	DESCRIPTION	VALUES OF COEFFICIENT C		
			Range	Average	Class
Silt loam..........	6	Variously fertilized	0.0015–0.0020	0.0018	0.002+
	1	Manured	0.0022	0.0022	
Silt loam..........	5	Limed, in part	0.0037–0.0063	0.0053	0.005−
Mediacid peat.....	4	Cranberry bog	0.0040–0.0070	0.0055	
Silt loam..........	3	Limed, balance	0.0075–0.0091	0.0085	0.01
Gravelly loam.....	1	In part	0.010	0.010	
Gravelly loam.....	2	In part	0.019 −0.026	0.023	0.02+
	7	Limed, in part	0.018 −0.036	0.027	
Gravelly loam.....	3	Balance; limed, in part	0.038 −0.050	0.044	0.05−
Subacid peat......	4	Cranberry bog, depths	0.036 −0.064	0.047	
Subacid peat......	2	Cranberry bog, others	0.076 −0.077	0.077	0.1
Gravelly loam.....	3	Limed, in part	0.076 −0.136	0.100	
Subacid peat......	2	Limed, balance	0.166 −0.200	0.183	0.2+
Gravelly loam.....	1	Limed, balance	0.200 −	0.200	

Since this paper was prepared, over a year ago, a new series of comparisons of lime-requirement and active acidity has been published by Harlan W. Johnson.[9] On calculating the coefficient C for his data, the following classes are found to be represented:

TABLE 2

Fine sandy loam...	1	Knox	0.007–	0.007	0.005
Fine sandy loam...	1	Buckner	0.015–	0.015	0.01
Various loams.....	7	Lindley, O'Neill, etc.	0.023–0.035	0.028	0.02
Various loams.....	10	Plainfield, Shelby, etc.	0.037–0.070	0.050	0.05
Various loams.....	10	Buckner, Tama, etc.	0.077–0.121	0.086	0.1
Various loams.....	7	Judson, Marshall, etc.	0.166–0.301	0.234	0.2
Various loams.....	2	Wabash, Waukesha.	0.378–0.588	0.483	0.5
Various loams.....	2	Hancock, Bremer	0.9 −2.5		high

Again the values of C show a wide range. This author furnishes data on organic matter present in these soils, and it is interesting to find that on plotting the values of C against the organic matter, they are found to be on the whole proportional; it is also striking that the lime-requirement itself is a function of the organic content, averaging one-sixth of the latter. These relations indicate that the organic

[9] Soil Sci., **13**: 7. 1922.

colloids are more important than the inorganic in furnishing hydrogen-ion to be neutralized by lime. The lack of relation between P_H and organic matter is not opposed to this, for the amount of organic acids needed to yield the P_H values shown is infinitesimal in comparison with the total organic content.

Summary.—In this paper lime-requirement is stated in parts per thousand of CaO; and, because of the ease with which relative values can be appreciated, active soil acidity is stated in the form of specific acidity. The ratio between these in a given soil may be expressed by a correlation coefficient C obtained by the equation: L.R. = C × (S.A. − 1). The value of C is believed to be a measure of the adsorptive power of the soil colloids for hydrogen-ion.

The coefficient C has been found to vary so widely from one soil to another, from an untreated to a limed soil, and even from one depth to another in the same soil, that it is impracticable to calculate lime-requirement from acidity determinations in general, as has been proposed. Soils may be roughly classified on the basis of the value of C, a convenient ratio between classes being $\sqrt[3]{10}$; but only if some simple procedure is first devised for classifying a given soil can there be obtained from its specific acidity a value for its lime-requirement.

BOTANY.—*Two new genera related to* Narvalina. S. F. BLAKE, Bureau of Plant Industry.

The type species of *Narvalina*, *N. domingensis* (Cass.) Less., is a shrub known only from the island of Hispaniola (Santo Domingo) in the West Indies. It is closely allied to the widespread and variable genus *Bidens* to which our "sticktights" or "devil's pitchforks" belong, being distinguished chiefly by its shrubby habit, coriaceous leaves, and wing-margined achenes. Although still rare in herbaria, at least in this country, it is represented in the National Herbarium by two sheets of excellent specimens collected by Mr. Emery C. Leonard, who accompanied Dr. W. L. Abbott on a collecting trip to Haiti in 1920.

Up to 1900 only the original species had been referred to the genus. In that year three new species were described from Ecuador by the German student of Asteraceae, Georg Hieronymus. All three are now represented in the U. S. National Herbarium by fragments of the types recently received from Berlin. Study of these fragments, consisting of fruiting heads accompanied by portions of the leaves, shows that they represent two rather remarkable new genera.

One of these, to which belong *Narvalina corazonensis* and *N. homogama* of Hieronymus, includes also the Peruvian plant lately described as *Bidens mirabilis* Sherff. Dr. Earl E. Sherff, who has been occupied for some years in a revision of the genus *Bidens*, ascribed his new species to that genus with some hesitation, and as the result of renewed study of the plant has come independently to the conclusion that it must be distinguished generically. The new genus, which it is proposed to name *Ericentrodea*[1] in allusion to its numerous pappus awns, is accordingly published jointly by Dr. Sherff and the writer. It is distinguished from *Narvalina* by having the achene distinctly contracted at apex into a short neck or collar produced, at least in two of the species, into two very short branches each bearing about 3 to "8" fragile, retrorsely hispid awns. It differs from *Bidens* in the same features, as well as in the presence of achene wings, which, however, are nearly obsolete in *N. homogama*, or even completely so in *B. mirabilis*.

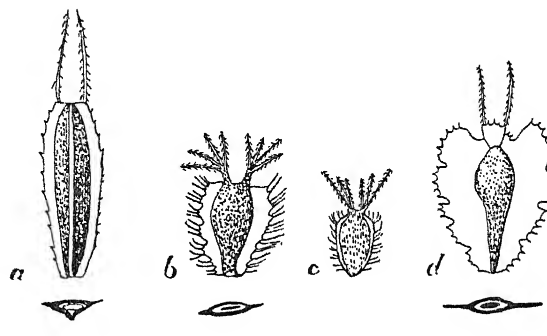

Fig. 1. *a*, achene of *Narvalina domingensis* (Cass.) Less. (*Leonard* 4832); *b*, *Ericentrodea corazonensis* (Hieron.) Blake & Sherff (*Sodiro* 44/2); *c*, *E. homogama* (Hieron.) Blake & Sherff (*Sodiro* 44/1); *d*, *Cyathomone sodiroi* (Hieron.) Blake (*Sodiro* 44/3). All × 3.

The other genus, represented only by *Narvalina sodiroi* Hieron., has a very broadly winged achene (similar in aspect to that of *Verbesina*, but obcompressed), bearing a pappus consisting of 2 very fragile awns and a turbinate spinulose-ciliolate corona about 1 mm. high, often adnate to the wings.

The distinctive characters of the three genera here considered are given in the following key.

[1] ἐρῖ, *much*, κεντρώδης, *prickly*.

Achene not contracted at apex; pappus of 2 awns only........1. *Narvalina.*
Achene contracted into a neck or collar at apex.
  Pappus of about 6 to 15 awns, more or less distinctly aggregated in two groups over the angles of the achene..................2. *Ericentrodea.*
  Pappus of 2 awns and a turbinate corona..................3. *Cyathomone.*

1. **Narvalina** Cass. Dict. Sci. Nat. **38**: 17. 1825.

Needhamia Cass. Dict. Sci. Nat. **34**: 335. 1825. Not *Needhamia* R. Br. 1810.

1. Narvalina domingensis (Cass.) Less. Syn. Comp. 234. 1832. Fig. 1, *a.*
Needhamia domingensis Cass. Dict. Sci. Nat. **34**: 336. 1825.
Narvalina fruticosa Urban, Symb. Antill. **5**: 265. 1907, excluding *Bidens fruticosa* L., the name-bringing synonym.[2]
Type locality: Santo Domingo.
Specimens examined: Haiti: Shrub 5 to 7 ft. high, occasional in arid thickets, vicinity of Pétionville, alt. 350 m., June, 1920, *Leonard* 4832 (U. S. Nat. Herb.); shrub 4 to 5 ft. high, scarce, vicinity of Fond Parisien, Etang Saumatre, May, 1920, *Leonard* 4098 (U. S. Nat. Herb.).

2. **Ericentrodea** Blake & Sherff, gen. nov.

Scandent shrubs or herbs (?), with opposite, petiolate, ternate or biternately divided, coriaceous leaves and cymose-panicled, discoid or radiate, yellow heads; involucre double, as in *Bidens*, the outer phyllaries small, herbaceous, the inner submembranous, lineate; receptacle flattish; pales flattish, membranous, lineate; rays when present pistillate, fertile; disk flowers[3] hermaphrodite, the corollas tubular, with slender tube, funnelform throat, and 5 short teeth; anthers with cordate-sagittate bases and ovate terminal appendages; style exserted, the branches short, with triangular, acuminate, papillose appendages; achenes strongly obcompressed, the obovate body distinctly or obsoletely 2-winged, coarsely ciliate on the lobulate margin, contracted at apex into a short neck or collar; pappus awns about 6 to 15, fragile, in two groups of 3 to "8" over the angles of the achene, those of each group usually more or less connate at base, with 2 or 3 shorter intermediate awns sometimes present on each side of achene between them.
Type species *Narvalina corazonensis* Hieron.

Heads radiate, in fruit about 1.7 cm. thick, 9 mm. high (corollas not included); lower leaves ternate, the upper simple............. 1. *E. corazonensis.*
Heads discoid, in fruit about 1 cm. thick, 6 mm. high (corollas not included); lower leaves biternate, the upper ternate or simple.
  Heads with 20 or more flowers; lower leaves biternate, the terminal divisions unlobed; pedicels up to 3 cm. long.......... 2. *E. homogama.*
  Heads about 12-flowered; lower leaves biternate, the terminal segments trilobate; pedicels about 1 cm. long................. 3. *E. mirabilis.*

1. **Ericentrodea corazonensis** (Hieron.) Blake & Sherff. Fig. 1, *b.*
Narvalina corazonensis Hieron. Bot. Jahrb. Engler **29**: 49. 1900.
Specimen examined: Ecuador: Subandine woods, Mount Corazón, altitude 2,000 meters, *Sodiro* 44/2 (fragments of type coll.; U. S. Nat. Herb. no. 1,059,379).

2. **Ericentrodea homogama** (Hieron.) Blake & Sherff. Fig. 1, *c.*
Narvalina homogama Hieron. Bot. Jahrb. Engler **29**: 48. 1900.

[2] See Blake, Journ. Bot. Brit. & For. **53**: 13–14. 1915.
[3] The floral characters are drawn from material of *E. mirabilis.*

SPECIMEN EXAMINED: ECUADOR: Subandine woods, between Cotocallao and Nono, *Sodiro* 44/1 (fragments of type coll.; U. S. Nat. Herb. no. 1,059,381).

3. **Ericentrodea mirabilis** (Sherff) Blake & Sherff.
Bidens mirabilis Sherff, Bot. Gaz. **61**: 496. *pl. 31*. 1916.
SPECIMEN EXAMINED: PERU: Humabalpa, November, 1857, *Spruce* 6273 (fragments of type coll. in Gray Herb. and herb. Sherff; photograph in U. S. Nat. Herb.).

Described by Spruce as a climbing herb, but probably, like the other species of the genus, either shrubby or suffrutescent. The heads examined have only young achenes. In these the awns, borne on a definite although short neck, are usually in two groups of 5 or sometimes 6 over the angles of the achene, agreeing in this respect with those of the other two species, but they do not seem to be united at base. In a few achenes, however, there were 2 or 3 shorter awns on each side of the achene between the main groups of awns. One achene examined bore altogether 15 awns, 5 each in the two groups and 5 smaller ones between them. From the appearance of some of the young achenes, it seems probable that a narrow wing is developed at maturity, at least in some cases.

3. **Cyathomone** Blake, gen. nov.

Shrub (?); leaves opposite, petioled, biternate or pinnate-ternate, membranaceous; heads 7 to 15, cymose, nodding, long-peduncled; involucre double, as in *Bidens*, the outer phyllaries about 5, herbaceous, the inner longer, submembranous; receptacle convex, the pales flattish, membranous, lineate; flowers unknown; achenes strongly obcompressed, the body narrowly obovate, contracted at apex, with two broad, ciliolate, somewhat pectinate-lobate wings, these usually adnate to the pappus cup; pappus of 2 very fragile retrorsely hispid awns and a turbinate, spinulose-ciliolate, persistent corona about 1 mm. high.
Type species *Narvalina sodiroi* Hieron.

1. **Cyathomone sodiroi** (Hieron.) Blake. Fig. 1, *d*.
Narvalina sodiroi Hieron. Bot. Jahrb. Engler **29**: 50. 1900.
SPECIMEN EXAMINED: ECUADOR: Subtropical woods along the Río Pilatón, *Sodiro* 44/3 (fragments of type coll.; U. S. Nat. Herb. no. 1,059,380).

The generic name, from *κυαφος*, *cup*, and *μονη*, *an abiding*, refers to the persistent corona.

BOTANY.—*Three new plants of the family* Rubiaceae *from Trinidad.*

N. L. BRITTON, New York Botanical Garden, and PAUL C. STANDLEY, U. S. National Museum.

Study of a collection of plants received by the New York Botanical Garden as a loan from the Trinidad Botanic Garden has revealed material of many interesting plants, particularly some not previously recorded from Trinidad. Among them are the three species of

Rubiaceae here described as new. The two new species of *Urceolaria* are of special interest, since this genus is a very small one, and only two species have been known hitherto to occur in the West Indies.

Evea tontaneoides Britton & Standl., sp. nov.

Plants herbaceous, the stems slender (1 to 1.5 mm. thick), ascending or decumbent, densely pilose with slender whitish spreading multicellular hairs; stipule sheath greenish, 2 to 3 mm. long, densely pilose, the lobes two on each side, lance-linear, 3 to 4 mm. long, long-ciliate, pilose on the outer surface; petioles slender, 4 to 6 mm. long, densely pilose; leaf blades lanceolate, lance-oblong, or oblong-ovate, 3 to 6 cm. long, 1.5 to 2.5 cm. wide, acute or acuminate, rounded and often unequal at base, thin, above deep green, pilose with long, slender, apparently appressed hairs, beneath pale and similarly pilose; peduncles solitary in the forks of the branches, slender, densely pilose, about 3 cm. long, the flowers few, sessile in a dense head; bracts obovate or spatulate, 4 to 6 mm. long, acute or apiculate, green, sparsely pilose; calyx lobes linear, green, pilose; corolla (in bud) villosulous.

Type in the Herbarium of the Trinidad Botanic Garden, collected at Caparo, Trinidad, October 26, 1916, by W. E. Broadway (no. 9774).

A well-marked species, in habit strongly suggesting certain plants of the genus *Tontanea*, of the same family.

Urceolaria clusiaefolia Britton & Standl., sp. nov.

Branches stout, brown, angulate, somewhat lustrous, the internodes 2 to 8 cm. long; stipules quickly deciduous; petioles stout, 1 to 1.5 cm. long, glabrous; leaf blades oblong-obovate to obovate-elliptic, 8 to 11 cm. long, 3.5 to 5.5 cm. wide, acute, often somewhat abruptly so, at base acute or acuminate and decurrent upon the petiole, coriaceous, glabrous, lustrous above, the costa shallowly channeled, the lateral nerves evident and slightly elevated, beneath brownish, the costa and lateral nerves prominent, the latter about 8 pairs, ascending at an acute angle, anastomosing to form a continuous nerve remote from the margin, the ultimate nerves prominulous and irregularly reticulate; peduncle over 1.5 cm. long, stout, the involucre entire, about 3 mm. long; calyx spathaceous, in fruit about 1 cm. long, the immature fruit 5 to 6 mm. in diameter.

Type in the Herbarium of the Trindad Botanic Garden, collected on Mt. Tocuche, Trinidad, August, 1847, *Botanic Garden Herbarium* 673.

Although only imperfect specimens are available for study, these differ so conspicuously in leaf characters from the other West Indian representatives of the genus that it seems safe to assume that they represent a distinct species.

Urceolaria angustifolia Britton & Standl., sp. nov.

Branches stout, angulate, glabrous, brownish, the internodes 1 to 3 cm. long; stipules caducous; petioles 6 to 10 mm. long; leaf blades oblong-oblanceolate or narrowly oblong, 4.5 to 8 cm. long, 1.2 to 2.5 cm. wide, obtuse, cuneate at base, coriaceous, glabrous, lustrous above, the costa shallowly channeled, the lateral nerves evident and slightly elevated, beneath brownish, the costa and lateral nerves prominent, the latter about 11 pairs, ascending at a very acute angle, curving outward and anastomosing remote from the

margin, the ultimate nerves slightly elevated, irregularly reticulate; peduncles terminal, solitary, 2.5 cm. long, the involucre entire, 3 mm. high; calyx in bud 1 cm. long.

Type in the Herbarium of the Trindad Botanic Garden, collected on Mt. Tocuche, Trinidad, June 21, 1907, by William Leslie (no. 9363).

While this may be only a form of *U. clusiaefolia*, the shape of the leaves is strikingly different, and it is probable that the present plant is specifically distinct. Flowering specimens of both are a desideratum.

ENTOMOLOGY.—*A new* Reticulitermes *from the Orient.* THOMAS E. SNYDER, U. S. Bureau of Entomology.

Reticulitermes Holmgren was established in 1913 as a subgenus of the genus *Leucotermes* Silvestri. N. Banks, in 1920, raised *Reticiultermes* to generic rank. I am adopting the generic value given this genus by Banks, although I am doubtful as to whether *Reticulitermes* can be considered of generic rank. I place *Reticulitermes* in the family *Rhinotermitidae*, since the species have protozoa (Trichonympha) in the guts and subcordate pronota which would exclude them from the family *Termitidae* where placed by Banks.

Species of both the genera *Leucotermes* and *Reticulitermes* are extremely destructive to timber and other woodwork. Winged adults of species of *Reticulitermes* are dark colored, with the wings strongly reticulated, but with few hairs or marginal cilia; they are species of relatively northern distribution, the centre of distribution being North America. Species of *Leucotermes* are lighter colored, have the margins of the wings ciliate and are of relatively southern distribution. I have recently revised this genus.

Only two species of *Reticulitermes* are known from the Orient; these eastern species are *R. speratus* Kolbe and *R. flaviceps* Oshima, both being from Japan. The new species to be described is from China.

Reticulitermes chinensis, sp. nov.

Winged adult.—Head dark castaneous-brown (dark finished mahogany), smooth, shining, semi-quadrilateral, but rounded posteriorly, slightly longer than broad; at anterior of head above the ocelli are two prominent white spots (muscle attachments); head with dense, long, light yellow hairs. Fontanelle a small white point on a line connecting the backs of the eyes.

Antennae grey-brown with tips of segments whitish, 17–18 segments, pubescent; first segment clavate, elongate; second cylindrical, shorter; third very short, ring shaped; fourth twice as long as third; fifth more wedge shaped, slightly shorter than fourth; sixth longer than fifth; last segment elongate, sub-oval.

Eyes purplish, not quite round, not very prominent, separated from the lateral margins of head by a distance less than an eye diameter. Ocelli separated from eyes by a distance less than their small diameter.

Labrum yellow-brown, semi-tongue shaped.

Post-clypeus yellow-brown, much broader than long.

Pronotum about same color as head, smooth, shining, subcordate, not as wide as head, emarginate both anteriorly and posteriorly, raised up anteriorly, with long hairs.

Legs with femora greyish-brown, tibiae and tarsi yellowish.

Wings smaller than in *flavipes* and in the forewing the median vein is intermediate between subcosta and cubitus, whereas in *lucifugus* it is nearer to the cubitus.

Wing scale longer than pronotum, being 0.80 mm. in length.

Abdomen with tergites slightly lighter colored (more grey), than head, with long hairs; cerci three segmented; styli present in the male.

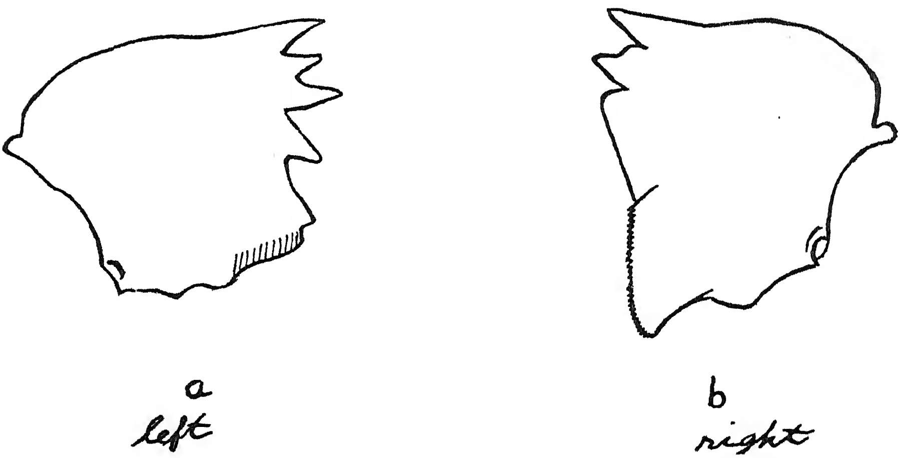

Fig. 1. Mandibles *a* left and *b* right, greatly enlarged

Measurements:

- Length of entire winged adult: 9.15–9.40 mm.
- Length of entire deälated adult: 4.8–5.2 mm.
- Length of head (to tip of labrum): 1.25 mm.
- Length of pronotum: 0.55 mm.
- Length of hind tibia: 1.15 mm.
- Length of anterior wing: 6.75–7.0 mm.
- Width of head (at eyes): 1.15 mm.
- Diameter of eye (long): 0.225 mm.
- Width of pronotum: 0.95 mm.
- Width of anterior wing: 1.90 mm.

From descriptions, *R. chinensis* is a smaller, lighter colored species than *R. speratus* Kolbe; the head is more hairy in *chinensis* and the teeth of the mandibles slightly different (Fig. 1); the ocelli are nearer to the eyes; the pronotum is not yellow. In the forewing the median vein is more intermediate between the subcosta and cubitus than in *speratus*. Winged adults of *chinensis* were compared with winged adults of *Reticulitermes lucifugus* Rossi from Talheiro, Maderia; of *R. flavipes* Kollar from the eastern United States;

and *R. claripennis* Banks from Kansas. *R. chinensis* is smaller than *lucifugus;* the ocelli are larger and the post-clypeus and the tibiae are more greyish-yellow colored, not so light castaneous; the post-clypeus is shorter and the fontanelle is smaller. *Chinensis* has not the yellow tibiae and tarsi of *flavipes*, ocelli are nearer to the compound eyes and the pronotum is smaller as is the entire insect. *R. claripennis* has lighter colored wings.

Soldier.—Head light yellow-brown, not twice as long as wide, ratio of length to width 1:0.62–1:0.63, sides parallel; with dense long hairs, rounded posteriorly. Eye spots indistinct if present. Gula slender, width at center being about one-half the width at the front. Mandibles dark castaneous with a reddish tinge, "S" shaped, incurved at tips; at base of left mandible two small marginal teeth—one sharp tooth and one small, broader, blunt (double?) tooth; right mandible with no teeth. The basal knobs of the mandibles are not regarded as teeth.

Antennae white with a yellowish tinge, with 16 segments, pubescent; third segment short, ring-like; fourth twice as long as third; fifth equals fourth; sixth longer; last segment elongate and sub-oval.

Labrum yellow-brown, narrow, pointed at apex, where there are long hairs.

Pronotum white with tinge of yellow, not as wide as head, nor not nearly twice as broad as long, emarginate both anteriorly and posteriorly, turned up anteriorly.

Legs white, with tinge of yellow, pubescent.

Abdomen white with tinge of yellow, with dense long, light yellow hairs.

Measurements:

Length of entire soldier: 4.9–5.4 mm.
Length of head with mandibles: 2.6–2.75 mm.
Length of head without mandibles (to anterior): 1.85–1.90 mm.
Length of left mandible: 1.5 mm.
Length of pronotum: 0.55–0.6 mm.
Length of hind tibia: 0.95–1.0 mm.
Width of head: 1.10–1.20 mm.
Width of pronotum: 0.85 mm.

The soldier of *chinensis* has a larger pronotum than that of *speratus* Kolbe, and the mandibles have slightly different marginal teeth; the soldier of *chinensis* has a longer, broader head than that of *flaviceps* Oshima.

Type locality.—"Suifu, Szechuen, (or Szechwan) China."

Described from a series of winged adults collected at the type locality May 1, 1920, and in 1922, by D. C. Graham. Soldiers with workers were also collected, at the type locality, in 1922 by D. C. Graham.

Type, winged adult.—Cat. No. 26043, U. S. N. M.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY

SPECIAL MEETING

A special meeting of the Biological Society was held in the auditorium of the Interior Department on September 29, 1922, with President BAILEY in the chair and 240 persons present. Program:

DONALD R. DICKEY: *Exhibition of moving pictures of wild game of New Brunswick.* These pictures were taken on the upper waters of the Tobique River and across to the Nepisiguit. Views of the lakes and streams were shown, followed by numerous films of moose and deer, including many taken from a canoe. Both rapid and slow movement films were shown. Two of the most notable films showed ruffed grouse drumming. The bird could be seen to strike its wings together when drumming, both before and behind its body, which was in an erect position.

SPECIAL MEETING

A special meeting of the Biological Society was held at the Cosmos Club October 19, 1922, with the Washington Academy of Sciences and the Chemical Society of Washington, with President J. W. HUMPHREYS of the Washington Academy of Sciences in the chair and 94 persons present. Dr. H. J. HAMBURGER, Professor of Physiology in the University of Groningen, Holland, gave an address on the subject *The increasing significance of chemistry in medical thought and practice.*

642D MEETING

The 642d regular meeting of the Biological Society was held at the Cosmos Club November 11, 1922, with President BAILEY in the chair and 75 persons present. The program was as follows:

E. D. BALL: *Importance of adequate training for biological work in the Government service.* In the Government service at present, omitting Army and Navy, Indian Service, judges and attorneys, the number of men employed in some technical scientific line is 7074, of whom 4332 are actually engaged in their specialties. Of the latter, 2240 are in the Department of Agriculture and 2092 in other departments. In the whole Government service, scientific and other, the number of men who are paid salaries of $5000 and over reaches the total of 7761. Of these, 2490 are in the Civil Service. Four receive $25,000 or more; 183 receive $10,000 or more; 607 receive $7500 or more.

The following table of salaries of college professors was presented for comparison with that of scientific workers in the Government service.

In 7 leading endowed universities the range of salary for full professors listed in the graduate school was: minimum $4750, maximum $8550, average $5500.

In 7 leading state universities salaries range from $3200 to $7125, with an average of $4725.

In leading agricultural colleges $2850 to $4875, average $3750.

Of these faculties, 90 per cent in the first group had doctors' degrees, with a smaller percentage in the state universities, and still smaller in the agricultural colleges.

In the Department of Agriculture figures were obtained from four bureaus only. It was found that the average salary of men with doctor of philosophy degrees was $3372, with masters' degrees $2905, and with bachelors' degrees $2535. In connection with these figures, the speaker noted that many of the older men do not have the higher degrees, but have attained higher salaries through experience and seniority, so there would be a wider difference between the holders of different degrees, if only men of equal age and experience could be compared.

In conclusion, the speaker said the three objects of graduate study are the following: (1) to broaden the field of view; (2) to come in contact with great minds; and (3) to learn methods of research in the specialty involved.

G. N. COLLINS: *Maize and its wild relatives* (lantern). Maize is the only cereal whose wild prototype is unknown. The only wild plant known which is close enough to maize to give a clue to the origin of the latter is teosinte, a large Mexican grass of the genus *Euchlaena* There are two species, one perennial, the other annual. The latter hybridizes freely with maize, and all intergrades can easily be produced, but none of them maintain themselves in nature. Teosinte is a more highly specialized grass than maize, hence evolution must have gone backward if teosinte changed into maize. The theory that maize may have originated from teosinte by crossing the latter with some unknown plant similar to sorghum seems to accord best with the known facts.

N. A. COBB: *Nematodes inhabiting trees* (lantern). After a general account of nematodes or nemas, the speaker described in detail an outbreak of nemas on the coconut palms in the Canal Zone and vicinity. The nema was found in the roots and in a certain cylinder of trunk tissue; the latter turning red has given the name "red ring" to the disease. As there was no way to destroy the nemas within the tree, the speaker had turned his attention to methods of infection, and had found that the large palm weevils carry the worms from tree to tree. The gathering and destruction of the weevils on a large scale is believed to have checked the spread of the attack.

643D MEETING

The 643d regular meeting of the Biological Society was held at the Cosmos Club November 25, 1922, with Vice-President HITCHCOCK in the chair and 76 persons present.

The following new members were elected: J. C. BRIDWELL, S. C. BROOKS, E. F. FRIBLEY, L. G. HOOVER, P. B. JOHNSON, and EDMUND PLATT.

L. W. STEPHENSON gave a short account of the discovery of cypress stumps in an ancient swamp opened in excavating for the new Hotel Walker on Connecticut Avenue. As examined by the speaker, the top layer showed a recent fill of 10 to 12 feet; below this 7 or 8 feet of clay, then 5 to 8 feet of swamp deposit, then gray micaceous sand 12 to 15 feet deep, the lowest 3 to 5 feet becoming gravelly. The swamp layer, which is of the Pleistocene age, is a peaty clay, containing cypress stumps and knees with some seeds, balls and scales. Only a few logs were horizontal, most of them being vertical and truncated a little above the base. When dry, the wood burns freely. The only tree occurring is *Taxodium distichum*, the bald cypress, the present range of which extends to within twenty miles of the District. The speaker thought the estimate of 20,000 to 30,000 years as the age of the deposit was far too little. He illustrated the strata by means of a chart.

Dr. C. L. Marlatt then proposed an alternative explanation of the occurrence of the stumps. He exhibited an outline map taken from an old city map, from which it appeared that a stream called Slack Creek once flowed into Rock Creek from the vicinity of Dupont Circle, draining a large swamp to the north and east, and traversing the very spot where the excavation is now in progress. He therefore maintained that recent filling would account for all above the swamp layer, and this itself would date from the early white settlement of the District, about 260 years ago. He had been informed by one of the shovelmen that an old brick wall encountered in the digging was on the same level as the tree stumps.

There was some discussion of the second theory, leading only to the conclusion that much would depend on the existence of the supposed layer of clay 7 or 8 feet deep above the swamp and below the admitted recent fill. Dr. Marlatt had not detected this, but Mr. Stephenson had.

L. O. Howard: *Some informalities about pioneer workers in medical entomology* (lantern). The speaker showed lantern slides of a large number of pioneer workers, giving interesting facts or anecdotes about each.

C. W. Stiles: *Frequency of amoeba in man, and its significance in public health.* In the war zone there was a great meeting place for men of all nations, and it was anticipated that returning soldiers might be infected with the amoeba of dysentery to an extent which might endanger the whole population. A conference was held in Washington to discuss the matter before the soldiers returned. It was thought from figures obtained by Kofoid that there would be from 400,000 to 700,000 cases of the disease among the returned men. An extensive examination of various classes of the population was carried out to get a basis for comparison. A circular was sent to all hospitals and medical schools, inquiring if an increase had been observed in the disease as the men were returned. Only 4.5 per cent reported any increase. A total of 8029 persons in the general population were examined, of whom 333 were infected, or 4 per cent; of 196 immigrants, 25 per cent were infected; of 329 boys and girls in a school in the District of Columbia, 17 per cent; of 83 boys and girls in another school, between 8 and 9 per cent; of 1547 civilians, 13 to 17 per cent; of 2984 ex-soldiers who had not gone to Europe, 8 to 9 per cent; of 3536 soldiers who had been in Europe, 7.8 to 9 per cent; of 362 miscellaneous, 7 to 9 per cent. In these infected cases few showed symptoms of the disease, as they were evidently able to restore the infected tissue as rapidly as it was damaged. These were carriers rather than patients. A few years ago this distinction was not made, but now it is known to be of great importance. It appeared from the statistics collected that the returning men were no menace to the health of the country, as they were less infected than the population at home.

The disease is easily cured in early stages, but later on with much more difficulty, although a new remedy, a newly discovered drug, is able to reach the parasite in the lungs and liver, and promises to cure the chronic cases.

J. M. Aldrich, *Recording Secretary.*

644th MEETING

The 644th regular and 43d annual meeting of the Biological Society was held at the Cosmos Club December 9, 1922, with President Bailey in the chair.

The following 53 members were elected: Joseph Becker, Norwell Belt, R. A. Bogley, Jr., D. L. Brown, C. H. Calvin, Billie Cass, R. G. Congdon, A. D. Daughton, P. V. De Leon, W. S. Detwiler, E. F. Ducey,

J. V. FLANAGAN, M. C. FLOHR, H. D. FREIGER, J. L. FRETZ, CHARLES GESCHICKTER, H. A. GILBERT, L. S. GORDON, ANNE HOF, N. S. HUBERT, J. R. B. HUTCHINSON, M. A. JOHNSON, T. J. KELLY, ROSE E. KUNDAHL, W. H. LAWTON, P. MAHONEY, A. D. MARKS, G. A. MCLAIN, J. E. MCLAIN, E. C. MYERS, M. A. NORIEGA DE SABLA, J. L. O'CONNOR, R. C. ORRISON, K. J. OSTERHOUT, HERNDON PHILLIPS, EDMUND POPE, MARY E. QUICK, Dr. J. W. ROBERTS, F. G. RILEY, Jr., H. E. ROONEY, IGNATIUS RUTKOSKI, BENJAMIN SEILER, W. W. SPURGEON, JAMES STEWART, T. D. STEWART, F. E. STUART, ELIZABETH V. WADDLEY, E. E. WALTER, IDA WECKERLY, F. R. WEEDON, AVIS M. WITHERS, A. A. ZAPOLSKY, and E. E. ZIEGLER.

The reports of the Recording Secretary, the Corresponding Secretary, and the Committee on Publications were read and accepted.

The following officers were elected for the coming year: President, A. S. HITCHCOCK; Vice-Presidents. J. W. GIDLEY, S. A. ROHWER, H. C. OBERHOSLER, E. A. GOLDMAN; Recording Secretary, S. F. BLAKE; Corresponding Secretary, T. E. SNYDER; Treasurer, F. C. LINCOLN; members of the Council, C. E. CHAMBLISS, H. C. FULLER, H. H. T. JACKSON, W. R. MAXON, A. WETMORE. The President announced the membership of the Committee on Publications as follows: C. W. RICHMOND, Chairman, J. H. RILEY, T. E. SNYDER.

On motion of Dr. C. W. STILES it was moved that a committee on zoological nomenclature be appointed to coöperate with the International Commission on Zoological Nomenclature.

S. A. ROHWER, *Secretary protem.*

THE BOTANICAL SOCIETY OF WASHINGTON

161ST MEETING

The 161st regular meeting of the Botanical Society was held at the Cosmos Club, Tuesday evening, October 3, 1922, at 8 p.m. President SAFFORD opened the meeting. The minute of the last preceding meeting were not read, owing to their absence and that of the Corresponding Secretary, 41 members and guests were present.

The Executive Committee presented the names of Mr. PHILIP BRIERLEY of the Federal Horticultural Board, and Dr. A. G. JOHNSON of the Bureau of Plant Industry as candidates for membership.

Under Brief Notes, Mr. C. R. BALL presented Dr. JOHN PERCIVAL's lately published volume on *The wheat plant.* Mr. PIERCE announced the coming dahlia show of the Takoma Horticultural Club to be held October 6 and 7.

The regular program of the evening followed: Mr. N. G. TEODORO, Plant Pathologist of the Philippine Department of Agriculture and Natural Resources, spoke on *Philippine botany with special reference to the genus* Musa, followed by the *Present status of phytopathology in the Philippines.* The present knowledge of Philippine botany is due to the efforts of Prof. E. D. Merrill, Director of the Philippine Bureau of Science. He published the results of his findings in 1903. Little attention was given by the Spanish government to the study of the flora of the Islands. In fact the only work was the establishment of "The Flora and Forestry Commission" under the direction of Sebastian Vidal, which continued from 1876 till his death in 1889.

At the beginning of the 18th Century, Padre Hippolito Casiano Gomez, an Augustinian wrote an article in a native language on household remedies,

mentioning various plants. The greatest of the friar botanists was Padre Manuel Blanco, also an Augustinian. His work in Spanish, entitled Blanco's Flora de Filipinas, was first published in 1837. It is a work of 965 pages; the second and third editions were written after his death. Copies of all three editions, which are in the Department of Agriculture, were shown at the meeting. Most of the older herbaria in Manila were destroyed during or before the Insurrection; however two now remain, that formed by Regino Garcia in 1894, another collected by Dr. Leon Ma. Guerrero. The botanical libraries were also destroyed by fire about 1898.

Since the American occupation, real botanical work has progressed rapidly. With Prof. E. D. Merrill in 1903 were three other botanists, Dr. E. B. Copeland, Dr. H. N. Whitford, and Mr. A. D. E. Elmer, all of whom were attached to the Bureau of Government Laboratories. In 1905 this Bureau became the Bureau of Science. The herbarium of the Bureau of Science contains upwards of 200,000 specimens. The Philippine Journal of Science is the medium for publishing botanical articles. Quite a number of Filipino botanists received their training in the College of Agriculture, which was established in 1909, with Dr. Copeland as its founder and dean.

Mr. Teodoro began a classification of the genus *Musa* for the Philippine Government in 1915. He found the species not well defined, and in order to make a beginning in classifying them, he worked up the varieties. There are now about 600 varieties of bananas growing in cultivation at the College of Agriculture at Los Baños. The results of the classification of varieties have been published in *A preliminary study of Philippine bananas*, which appeared in the Philippine Journal of Science, Botany Section, Vol. 10, May 1916.

L. H. Dewey, discussed *Misleading names of plant fibers*.

There is more confusion in the common trade names of commercial fibers used in twine and cordage than there has been in recent years in the botanical names of plants. This results in errors in Government statistics, misunderstandings among dealers and manufacturers, and frequent monetary losses. The most serious trouble is due to the ambiguous use of the term hemp. This name was first used to designate the true hemp plant, *Cannabis sativa*, and the bast fiber obtained from that plant. It still has this specific meaning, but unfortunately it is also used in a generic sense as a substitute for the word fiber to designate nearly all long fibers, as manila hemp for abacá from the Philippines; sisal hemp for henequén from Yucatán, and sisal from East Africa; New Zealand hemp for phormium from New Zealand, and sunn hemp for sunn from India. The name of the country or definitive adjective is often omitted, leaving only the term hemp, which may mean any one of a dozen fibers.

Similar trouble is threatened by the use of the name sisal to designate not only the true sisal from *Agave sisalana*, but all other fibers from Agaves and Furcraeas, and the name jute to designate true jute and also all fibers similar to jute.

It is suggested that an authoritative list of fibers be published to correct these misleading and costly errors.

Mr. P. L. Ricker spoke of *The proposed Mt. Hamilton Botanical Garden*, which was still before Congress for consideration.

The regular meeting than adjourned and the annual meeting was held. The report of the Executive Committee showed the following facts concerning the activities of the preceding year: average attendance of the 8 regular meetings was 66; at a special meeting there were 110 present. Eighteen new

members were elected during the year. One member died. The total membership at this time is 161. The following officers were elected for the ensuing year: President, L. C. CORBETT; Vice President, H. L. SHANTZ; Recording Secretary, ROY G. PIERCE; Corresponding Secretary, R. KENT BEATTIE; Treasurer, W. W. GILBERT.

ROY G. PIERCE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The ACADEMY'S list of one hundred popular books in science has been republished with notes by the American Library Association, under the title *Popular books in science, a reading list.* Copies will shortly be distributed to members of the ACADEMY. Additional copies may be purchased from the American Library Association, Chicago.

The Swedish Legation arranged a special lecture on the iron, steel, and timber industries of Sweden, which was given before the School of Foreign Service, Georgetown University on Friday, February 9. The lecturer was Dr. HARRY von ECKERMANN, the managing director of the Ljusne-Woxna Company, the largest iron works in Sweden.

The newest scientific organization in Washington is the Mineralogical Society which held its first meeting on Friday, February 23. *Space isomorphism in minerals* was discussed by Dr. E. T. WHERRY, and *Ptilolite and related zeolites* by Dr. W. T. SCHALLER. The secretary, Dr. W. F. FOSHAG, U. S. National Museum, will be pleased to hear from anyone interested in future meetings.

At the meeting of the Petrologists' Club on Tuesday, February 20, Messrs. L. H. ADAMS and E. D. WILLIAMSON discussed the *Elastic behavior of minerals and typical rocks.* The evidence as obtained by laboratory experiments and by seismological observations was briefly reviewed and its bearing on questions relating to the constitution of the earth considered.

A recent Act of Congress authorizes The Regents of the Smithsonian Institution to prepare preliminary plans for a suitable fireproof building with granite fronts, for the National Gallery of Art, including the National Portrait Gallery and the history collections of the U. S. National Museum.

The National Baird Memorial Committee met in the U. S. National Museum Saturday, February 3. This Committee was composed of delegates appointed by fifty-four scientific societies and institutions from the various parts of the country, and the following officers: Honorary President, Dr. WILLIAM H. DALL; President, Dr. CHARLES D. WALCOTT; Vice-Presidents, Mr. GEORGE R. AGASSIZ, Dr. FRANK W. CLARKE, Dr. STEPHEN A. FORBES, Dr. DAVID STARR JORDAN, Dr. EDWIN LINTON, Dr. EDWARD S. MORSE, Dr. HENRY FAIRFIELD OSBORN, Dr. ADDISON E. VERRILL and Dr. ROBERT S. WOODWARD; Secretary, Dr. PAUL BARTSCH.

The purpose of the meeting was to decide upon the form of the memorial or memorials to SPENCER FULLERTON BAIRD, former Secretary of the Smithsonian Institution, the virtual founder of the U. S. National Museum, the creator and head of the U. S. Fish Commission, and a prime mover in the establishment of the U. S. Geological Survey and the Bureau of American Ethnology.

The centenary of the birth of Professor Baird was celebrated in the evening in the auditorium of the National Museum. The following addresses were delivered: *Baird, the man,* Dr. WILLIAM DALL; *Baird and the Smithsonian Institution and its branches,* Dr. C. G. ABBOT; *Baird at Woods Hole,* Dr. EDWIN LINTON; *Baird and the fisheries,* Dr. DAVID STARR JORDAN; *Baird, the naturalist,* Dr. C. HART MERRIAM.

A public announcement was made of the report of the National Committee, as follows:

1. That Congress be memorialized to establish in the city of Washington a museum of fisheries and oceanography, with laboratories and a public aquarium, as a memorial to Spencer Fullerton Baird.

2. That there be established a fund for the encouragement of research and exploration in the directions in which Spencer Fullerton Baird was a leader.

3. It was the sense of the meeting that the name of Baird be given to the laboratory of the Bureau of Fisheries at Woods Hole, Massachusetts.

On Monday, February 19, the four hundred and fiftieth anniversary of the birth of Copernicus, a commemorative meeting was held in the U. S. National Museum. Dr. C. G. ABBOT gave a brief address on *Copernicus, his life and astronomical theory.*

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GEOLOGY.—*An outline of the results of a geological reconnaissance of the Republic of Haiti.* Wendell P. Woodring.[1]

CONTENTS

INTRODUCTION

According to arrangements between the Department of Public Works of the Republic of Haiti and the United States Geological Survey, a geological reconnaissance of the Republic of Haiti was made in the winter of 1920–1921 under the supervision of the United States Geological Survey. Mr. J. S. Brown, Mr. W. S. Burbank, and I arrived in Port-au-Prince on October 1, 1920. We were in the field continuously until April 15, 1921, when we sailed from Port-au-Prince. We made a general reconnaissance of the entire Republic, including Gonave Island and Tortue Island. A detailed reconnaissance was made of some regions in order to obtain information on certain mineral deposits and on underground water resources. The highest and most inaccessible parts of some of the rugged mountains, such as the Montagnes Noires, the Montagnes de la Selle, and the Montagnes

[1] Published by permission of the Acting Director of the United States Geological Survey and the Engineer-in-Chief of the Republic of Haiti.

de la Hotte, were not examined. The field work and most of the office work was done under the supervision of Dr. T. W. Vaughan of the United States Geological Survey.

A complete report embodying the results of the reconnaissance, illustrated with many maps, diagrams, and photographs, has been prepared for publication, and it is intended to issue a French and an English edition. As this report will not be ready for distribution before the autumn of 1923, the following summary of the results of the reconnaissance is now published.

GEOGRAPHY

All the inhabitants of the Republic know that it is very mountainous. The only extensive plains are the North Plain, the Central Plain, the Artibonite Plain, and the Cul-de-Sac Plain. The Central Plain is the only large interior plain. The most important of the smaller plains are the Arcahaie Plain, the Léogane Plain, and the Cayes Plain. All of these plains, except the Central Plain, have played an important part in the agricultural development of the Republic.

The Cul-de-Sac Plain is one of the most striking geographic features. It is part of a trough extending from Port-au-Prince Bay southeastward across the island to Neiba Bay and containing two lakes that have no outlet, Étang Saumâtre in the Republic of Haiti, and Hoya de Enriquillo in the Dominican Republic. It has been known for a long time that recently, geologically speaking, this trough was below sea level, dividing the island into two parts.

Aside from these plains most of the Republic, except part of the Northwest Peninsula, is mountainous. The highest mountains are in the southern part of the Republic. Mt. La Selle, the highest peak according to available information, has an altitude of 2,680 meters above sea level, as determined by triangulation under the supervision of the United States Geological Survey.

Contrary to the prevailing opinion the major geographic features are arranged in arcs convex both northward and southward. Most of the arcs trend northwestward. The geographic provinces, some of which have not heretofore been named, and their characteristic surface features are described in the final report.

GEOLOGY

Sedimentary rocks.—The oldest sedimentary rocks are schists that crop out on the North Plain and on Tortue Island. As these

rocks are not close to any known intrusive igneous rocks, and as they are so altered by metamorphism, it is believed they may be as old as Paleozoic.

Extensive areas in the northern part of the Republic contain argillites of supposed lower Cretaceous age. These sediments were deposited principally along the flood plains of streams. Impure marine limestones, probably of the same age, were found in the southern part of the Republic. Upper Cretaceous limestones that contain reefs of the peculiar rudistid mollusks found in Jamaica and other West Indian islands were discovered in the Arrondissements of Cap-Haïtien and Grande-Rivière du Nord.

Rocks of Tertiary age are very widely distributed in the Republic. Their succession and their equivalents in the Dominican Republic and other regions near by are shown in the table on page 20. The Eocene and Oligocene rocks are almost exclusively limestones, but the Miocene and Pliocene beds consist principally of clastic rocks. The Eocene and Oligocene limestones crop out on the crest and flanks of the mountains, and the Miocene and Pliocene clastic rocks in the plains and lowlands.

The Eocene is the most extensive series of rocks in the Republic. The Plaisance limestone, of middle Eocene age, is confined to the northern part of the Republic. It is characterized by undescribed species of Foraminifera of the genus *Dictyoconus*.[2] Limestone of upper Eocene age is perhaps the most common surface rock in the mountains and it has a maximum thickness of more than a thousand meters. It contains an extensive foraminiferal fauna, principally orbitoidal Foraminifers of the genera *Orthophragmina* and *Lepidocyclina*. Upper Eocene Foraminifera were collected at about 90 localities.

Rocks of known lower Oligocene age were not seen during the reconnaissance. Middle Oligocene limestones were found in many parts of the Republic, particularly in the Montagnes Noires, the Chaîne des Mateux, and near Jacmel. These rocks are characterized by certain species of *Lepidocyclina*. Limestones of upper Oligocene age are extensive around the borders of the Plaine Centrale, in the mountains north of Étang Saumâtre, south of Gros-Morne, and elsewhere. They contain the foraminiferal genera *Lepidocyclina*, *Niogypsina*, and *Sorites*, and a fairly large coral fauna.

[2] See Woodring, W. P., Middle Eocene Foraminifera of the genus *Dictyoconus* from the Republic of Haiti: Journ. Washington Acad. Sci., **12**: 244–247, 1922.

TERTIARY SEDIMENTARY ROCKS OF THE REPUBLIC OF HAITI

American time subdivision		Republic of Haiti		Dominican Republic		Localities of some other American equivalent	European time subdivisions
Pliocene.		Hinche formation (non-marine). Conglomerates and marl near Jacmel.		Las Matas formation (non-marine.)		Panama, Jamaica, Cuba, and Costa Rica.	Sicilian. Astian. Plaisancian.
Miocene.	Upper.			Cerros de Sal formation.		Yorktown and Duplin formations of Virginia and North Carolina.	Pontian Sarmatian. Tortonian.
Miocene.	Middle.	Conglomerate, sandstone, and limestone along south edge of the Plaine du Cul-de-Sac.		Yaque group.	Mao clay. Mao Adentro limestone. Gurabo formation.	La Cruz marl, Cuba; Bowden marl, Jamaica; upper part of Gatun formation, Panama; Porto Rico; Calvert, Choptank, and St. Mary's formation, Maryland and Virginia.	Helvetian.
Miocene.	Lower.	Artibonite group.	Las Cahobas formation.	Yaque group.	Cercado formation.	Middle part of Gatun formation, Panama; Porto Rico; Shoal River marl and Oak Grove sand members of Alum Bluff formation, Florida.	Burdigalian.
			Thomonde formation and Maïssade tongue.		Baitoa formation.*		
			Madame Joie formation.		Bulla conglomerate.*	Lower part of Gatun formation, Panama; eastern Porto Rico; Chipola marl member of Alum Bluff formation, Florida.	

Oligocene.	Upper.	Limestone around border of the Plaine Centrale and elsewhere.	Cevicos limestone. Limestone east of Baní and elsewhere.	Anguilla; St. Croix; Porto Rico; Cuba; Panama; Tampa, Florida.	Aquitanian.
				Byram calcareous marl,‡ Mississippi.	Chattian.
	Middle.	Limestone in *Montagnes Noires*, Chaîne des Matheux, and elsewhere.	Tabera formation.† Limestone near Túbano.	Antigua; St. Croix; Porto Rico; Cuba; Panama; eastern Mexico; Glendon limestone, Gulf States.‡	Rupelian.
	Lower.			Red Bluff clay, Alabama and Mississippi; Marianna limestone, Gulf States.	Lattorfian.
Eocene.	Upper.	Limestone in all the mountain ranges.	Limestone at Damajagua, in Sierra de Neiba, Sierra de Bahoruco and elsewhere.	St. Bartholomew; Cuba; Trinidad; Ocala limestone, and Jackson formation, Gulf States.	Priabonian.
	Middle.	Plaisance limestone.		Claiborne group, Gulf States.	Auversian. Lutetian.
	Lower.			Trinidad; Midway and Wilcox groups, Gulf states.	Ypresian. Sparnacian. Thanetian. Montian.

* Largely contemporaneous.
† May include lower Oligocene.
‡ Age based on unpublished information furnished by C. W. Cooke.

Miocene rocks, consisting principally of conglomerate, sandstone, siltstone and marl, floor the Central Plain, the Artibonite Valley and other lowlands. Crumpled Miocene rocks extend along the southern edge of the Cul-de-Sac Plain and are exposed in road cuts and ravines near Port-au-Prince. A preliminary account of the Miocene beds of the Central Plain has already been published.[3] Copies of this report may be obtained by applying to the Engineer-in-Chief of the Republic of Haiti. The Miocene rocks in the Central Plain were studied in greater detail than those of any other region, and extensive series of fossils were collected. The Thomonde formation, one of the divisions of the Miocene beds, contains a molluscan fauna of more than 300 species, in addition to Foraminifera, corals, and Bryozoa. A limestone at the base of the overlying Las Cahobas formation contains a large number of reef corals. Other collections of Miocene corals and mollusks were obtained at many localities in the Artibonite Valley and elsewhere. A description of unusual specimens of *Orthaulax aguadillensis* Maury, one of the most striking and common mollusks in the Thomonde formation, is awaiting publication.[4]

Marine rocks of Pliocene age were found in the valley of Rivière Gauche and in nearby regions near Jacmel. An interesting fauna of corals and mollusks was obtained from these beds. Flood-plain deposits, called the Hinche formation, cover extensive areas in the Central Plain. These and similar beds in other lowlands may be of Pliocene age.

Marine Pleistocene deposits, consisting principally of coral reef rock and coralliferous limestone, were discovered in many parts of the Republic. They are most extensive in the western part of the Northwest Peninsula, where they cover the Bombardopolis Plateau and the magnificent emerged terraces that lead down from the plateau to the sea like gigantic stairs. In this part of the Republic these Pleistocene rocks are at an altitude of 400 meters above sea level. Pleistocene coral reefs were found in the Cul-de-Sac Plain, especially along the southern border of Étang Saumâtre. Pleistocene flood plain deposits are common in the lowlands.

More than 300 collections of fossils were obtained from the Cretaceous, Tertiary, and Pleistocene rocks, including Foraminifera, corals, crinoid stems, Echini, Bryozoa, brachiopods, mollusks, ostracods,

[3] Woodring, W. P., Stratigraphy, structure, and possible oil resources of the Miocene rocks of the Central Plain: Rep. Haiti Geol. Survey, 19 pp., map, 1922.

[4] Woodring, W. P., Tertiary mollusks of the genus *Orthaulax* from the Republic of Haiti, Porto Rico, and Cuba: Proc. U. S. Nat. Mus. (in press).

barnacles, decapod Crustacea, fish, birds, mammals, and plants. The largest number of collections are from Eocene and Miocene rocks, which are the most widely distributed. Unusually interesting collections of extinct Quaternary mammals and birds were obtained from caves near St.-Michel de l'Atalaye. In addition to remains of ground sloths and rodents, parts of a huge barn owl were found. This owl must have been a very powerful bird and apparently was the marauder responsible for the numerous remains of rodents found in the caves. Accounts of these remains have been published.[5] Further exploration of these and other caves should reveal a large Pleistocene fauna.

A paper describing the fossil plants collected, all of which are of Miocene age, is also in press;[6] another paper describes Miocene fish remains.[7]

Igneous rocks—Most of the igneous rocks are older than the sedimentary rocks and crop out on the crests of anticlinal arches in the mountains or in deep valleys where streams have cut through the cover of sedimentary rocks.

The oldest known igneous rocks are principally basalts that cover large areas in the northern part of the Republic. They are intruded by pyroxenites, peridotites, and diabases. These early igneous rocks are generally much altered and metamorphosed. Pyroxene and hornblende andesites and dacites in the same region are somewhat younger. Eruptions of basaltic rocks followed the andesites in some localities. There are minor amounts of tufaceous and agglomeratic rocks associated with the lava flows. All these volcanic rocks are the result of intense and long continued vulcanism in probably early and middle Mesozoic time.

The widely distributed basalts of the southern part of the Republic are of late Cretaceous age. They are remarkably uniform over the entire Southern Peninsula.

Toward the end of Cretaceous time or in early Eocene time the old lavas and younger argillites in the northern part of the Republic were intruded by batholiths and stocks of quartz diorite. The older igneous

[5] Miller, G. S., Jr., Remains of mammals from caves in the Republic of Haiti: Smithsonian Misc. Coll., 74[3]: 8, 1922.

Wetmore, A., Remains of birds from caves in the Republic of Haiti: Smithsonian Misc. Coll., 74[4]: 4, 2 text figs., 1922.

[6] Berry, E. W., Tertiary fossil plants from the Republic of Haiti: Proc. U. S. Nat. Mus. (in press.).

[7] Cockerell, T. D. A., A fossil Cichlid fish from the Republic of Haiti: Proc. U. S. Nat. Mus. (in press).

rocks are greatly altered near the contacts. Dacite porphyry in the Montagnes Noires may be of the same age.

In the Terre-Neuve district stocks of Quartz diorite were intruded into the old lavas and the Eocene limestone probably during Miocene time. This intrusion has a direct bearing on the genesis of the ore deposits of the Terre-Neuve district.

At the end of middle Oligocene time there were flows of nephelite basalt, an unusual type of rock in the West Indies, in the mountains between the Cul-de-Sac Plain and the Artibonite Valley.

Several hundred specimens of igneous rocks were collected. Chemical analyses have been made of 5 specimens.

Tectonics.—During late Mesozoic and Tertiary time the West Indian region was part of the great equatorial geosyncline that apparently almost completely encircled the globe. In the Republic of Haiti, as in other parts of the geosyncline, the Mesozoic and Tertiary rocks were crumpled during the Alpine period of folding. One of the surprising results of the reconnaissance is the discovery that the tectonic features of so large a part of the Republic are due to folding and crumpling of the rocks during and at the end of Miocene time. The Montagnes Noires, the Chaîne des Mateux, and its prolongation eastward to the Dominican border, are anticlinal arches formed at the end of Miocene time. The Central Plain, Artibonite Valley and Cul-de-Sac Plain are deep synclinal troughs of the same age. Miocene beds are involved in the folding in the Northwest Peninsula. Many of these mountain ranges and troughs are bordered by high-angle thrust faults. A zone of imbricated high-angle thrust faults is well exposed along the southern border of the Cul-de-Sac Plain. Similar thrust faults were found along the northern border of the plain, showing that this trough is not a down-faulted block, bounded by normal faults, as had previously been supposed. Marine Miocene beds underlying an interior lowland in the Commune of Jérémie are now separated from the sea by a high range composed of limestone of upper Eocene age. Lignite-bearing beds of Miocene age at Camp Perrin are thrust northward and are separated from the Cayes Plain by a range of upper Eocene limestone probably thrust northward.

The results of the folding at the end of Miocene time are most apparent in the central part of the Republic, which was very mobile during most of Tertiary time and where a great thickness of Oligocene and Miocene deposits were laid down. The movements continued into Pliocene time, as marine Pliocene beds near Jacmel are crumpled.

It is believed that there were earlier periods of folding at the end of Cretaceous time and at the end of Eocene time, but the folds can hardly be disentangled from the more extensive folds at the end of Miocene time, as they usually have the same trend.

No extensive overthrust sheets such as characterize the Alpine folds in so many parts of the Tertiary equatorial geosyncline were discovered, although there are many high-angle thrust faults along which the horizontal movement has not been very great.

In the mobile central part of the Republic and in the Northwest Peninsula the distribution of the emerged Pleistocene coral reefs is directly related to the folds produced at the end of Miocene time. The coral reefs, or coralliferous limestones, are at the greatest altitude on the crests of the anticlines, clearly showing that the arching of the rocks continued during Pleistocene time. These movements probably are going on even at the present time.

The tectonic features, like the geographic features which they control, are arranged in arcs convex northward and southward. Most of the arcs trend northwestward, but an arc in the Northwest Peninsula bends southwestward and at the western end of the Southern Peninsula arcs branch out in sheaf-like fashion.

Troughs like the Central Plain, Artibonite Valley and Cul-de-Sac Plain, which clearly are deep synclines bounded in part by high-angle thrust faults, are similar to the much larger submerged troughs of the West Indies, like the Bartlett Deep. It has been suggested that the submerged troughs are similar tectonic features.[8] The submerged troughs have heretofore been interpreted as down faulted blocks bounded by normal faults.

Earthquakes.—The Republic, like other parts of the Tertiary equatorial geosyncline, has numerous earthquakes. Disastrous earthquakes have at times almost or completely destroyed Port-au-Prince, Cap-Haïtien, and other cities. Father Scherer, Director of the Observatoire Météorologique du Séminaire-Collège St.-Martial, years ago ably showed the relation between the earthquakes and the known tectonic features. This relation and the bearing of the earthquakes on methods of building construction are discussed in the final report.

[8] See Wooding, W. P., Tectonic features of the Republic of Haiti and their being on the geologic history of the West Indies: Abstract, Journ. Washington Acad. Sci. (in press).

MINERAL RESOURCES

Metals.[9]—At the present time there are no active mining operations in the Republic, although prospecting has been carried on in several regions and some ore has been shipped.

The Terre-Neuve district contains probably the most extensive ore deposits. Copper is the principal metal in the deposits of this district, but there are small amounts of silver and gold. The ore deposits are contact metamorphic deposits in the upper Eocene limestone at the contact with the intrusive quartz diorite, and vein deposits in the porphyritic phase of the quartz diorite, and in the older basalts and pyroxene-andesites. Chalcopyrite is the principal copper mineral in the contact metamorphic deposits. Bornite and chalcocite are the principal copper minerals in the enriched vein deposits. Most of the ore is of low grade, although small amounts of rich ore are found both in the contact metamorphic deposits and in the enriched veins. More thorough prospecting is needed to reveal fully the possibilities of the district.

Copper-bearing veins were examined at a number of other places in areas of pre-Tertiary igneous rocks. Near Grande-Rivière du Nord there are small veins of solid chalcocite ore, but large amounts of low grade ore would have to be mined in order to work them.

Deposits of manganese ore, apparently hot springs deposits, were discovered in the Commune of Gros-Morne. The deposits examined are of low grade and contain a prohibitive amount of silica. Another deposit at the contact between upper Eocene limestone and basalt north of Jacmel is similar in many features to the deposit in the Commune of Gros-Morne.

Deposits of magnetite and hematite were examined at Morne Beckley in the North Plain. In many parts of the Republic there are residual deposits of low grade iron ore consisting of hematite and clay.

Fifteen samples of ores have been assayed and analyzed.

Non-metals.—The Republic of Haiti contains probably the most extensive deposits of lignite in the West Indies. Miocene beds in the Central Plain near Maïssade contain beds of high-grade lignite that have a maximum thickness of 2 meters or more. All of the beds examined contain partings of carbonaceous clay and bone that would

[9] The statements on the metals and non-metals here given were translated into French and published in Rapport annuil de l'Ingénieur en Chef au Secrétaire d'État des Travaux Publics, Répub. d'Haiti, pp. 50–52, 1922.

have to be discarded in mining operations. In a large part of this potential lignite field the beds dip very gently and the lignite could be mined by stripping off the overburden. The Miocene beds in this part of the Central Plain are coastal swamp deposits.

Lignite of entirely different origin and composition was examined in the interior lowland at Camp Perrin in the Arrondissement of Cayes. The beds here, which are also of Miocene age, are non-marine, and the lignite is probably an undeveloped cannel coal. This lignite could hardly be profitably mined, as the beds of good lignite are thin and all the beds are crumpled and faulted. Samples of lignite from both regions have been analyzed.

Miocene beds in the Central Plain contain mother rock and reservoirs suitable for the accumulation of oil. Favorable structural features were examined and have already been described.[10] Seeps of oil from these rocks have been reported by several people, but were not examined during the reconnaissance. There are no large-scale seeps, residues, or mud volcanoes, such as are found in many other regions where rocks of the same age contain oil. The oil possibilities of the Central Plain can be tested only by the drill.

Samples of limestone, marl, and argillite have been analyzed to determine the possibility of using them as raw materials in the manufacture of cement. Samples of different kinds of rock, gravel, and other material have been tested as road material. Gravels and sands have been tested as material for concrete and for other uses. Samples of clay have been tested as material for making bricks. The Republic contains a variety of rocks suitable for building stone and an unlimited supply of limestone that is burned for lime. At several places salt is obtained by the evaporation of sea water. Samples of cave guano have been analyzed to determine their value as fertilizers.

UNDERGROUND WATER RESOURCES

Perhaps the most intimate contact between geology and the inhabitants of the Republic lies in the development of the water resources. Most of the inhabitants depend upon agriculture for their livelihood and in many parts of the Republic it is necessary to supplement rainfall with irrigation. At the time of the reconnaissance there was little information available concerning the surface water resources. A program of measuring the flow of streams that are most

[10] Woodring, W. P., Stratigraphy, structure, and possible oil resources of the Miocene rocks of the Central Plain: Rep. Haiti Geol. Survey, 19 pp., map, 1922.

important with regard to present and proposed irrigation projects is now being carried out. During the reconnaissance a considerable amount of time was spent in studying the underground water resources of certain regions.

As soon as we arrived in Port-au-Prince, Mr. Brown began an examination of the geology of the region near Port-au-Prince with regard to the public supply of water. The present supply is derived from springs and during years of abnormally low rainfall it is inadequate for the rapidly increasing population of the capital. Mr. Brown made suggestions for the more effective utilization of some of the springs that are controlled by the geologic features. The water issuing in the springs falls as rain on the crest and north slope of Morne Hôpital, and as this mountain is composed wholly of limestone the water contains a large amount of calcium bicarbonate. The possibility of treatment to remove the hardness is discussed in the report. Ultimately the city should have a stream-fed supply. The Grande Rivière de Léogane (or Rivière Momance) probably contains an adequate amount, and as basalt is the surface rock in the greater part of its watershed its water should be much softer than the water derived from the springs near the city.

Mr. Brown also examined the inadequate spring-fed supply of Cap-Haïtien. Water of good quality to supplement or replace the present supply could be obtained from wells in the North Plain near by.

In the Cul-de-Sac Plain water derived from flowing and non-flowing wells is used to supplement the surface waters in irrigation. The possibility of obtaining a similar supply in some of the other plains is fully discussed in the report.

In many regions where limestone is the surface rock there are no surface streams, as the water seeps into channels and caverns in the limestone. At many places in limestone regions the inhabitants must depend for their supply upon salty springs issuing at the coast. At some of these places it is possible to obtain better water at little cost by tapping farther from the coast the underground streams feeding these springs.

The Republic contains many types of unusual springs, such as warm springs, sulphur springs, and salty springs. The geologic features of these springs were examined and samples of water from them were analyzed. There are also several interesting lakes, among them Étang Saumâtre. Samples of water from the lakes were analyzed. In all, 20 samples of water from streams, lakes, springs, and wells

were analyzed. The quality of these waters and the source of their mineral content are discussed in the report.

It is thus apparent that the reconnaissance has yielded results that are important contributions to the geologic history of the West Indian region. It has also yielded results that in many ways have an intimate bearing on the welfare of the inhabitants of the Republic—results based on an understanding of the geologic features derived from observations that at first glance may seem to be of purely scientific interest only.

BIOLOGY.—*The origin of the vertebrates.* AUSTIN H. CLARK, National Museum.

Heretofore all the writers on the subject of the evolution of the vertebrates have approached the problem with the complex vertebrate structure admittedly or unconsciously dominating the perspective within which all other types of animal structure should fall. Under the influence of this preconceived though unconfessed idea either a devious line was traced from the vertebrates through progressively simpler forms eventually ending in the protozoans, or a line was drawn from the protozoans to the vertebrates from which more or less numerous side branches were given off terminating blindly in supposedly anomalous types.

It never seems to have been noticed that animals and plants are but slightly different manifestations of the same organic phenomena, and that therefore there is no reason to suppose that the evolutionary line in one kingdom would be in its broader features greatly different from that in the other.

In the following pages I shall attempt to show that if we consider the phanerogam-like radially symmetrical colonial coelenterate type as representing the culmination of animal evolution properly so called, and the bilateral animals as having arisen through the disruption of this type and the gradual geometrical recombination of the characters of the forms resulting from this disintegration, we shall have an explanation of the origin of all the different animal types by which each and every one is allocated and shown to be a necessary element in the general plan.

The embryological processes common to all animals show that the egg develops into a blastula which subsequently becomes a gastrula; but from this point onward the developmental processes exhibit no features common to all animal types.

The gastrula, present in the ontogeny of all animals, is the last structural complex which is of universal occurrence throughout the animal kingdom and the last common bond between the various animal types, and it therefore must in some way represent the starting point for all subsequent divergence.

An egg typically divides into two, four and eight cells in three planes each of which is at right angles to the other two and, equal cell division continuing, a hollow sphere is formed, the blastula, which collapses, forming a more or less hemispherical structure with two layers of cells, an outer and an inner, the gastrula.

The gastrula possesses a single axis which runs through the center of the opening resulting from the collapse of the blastula; but since the walls of the gastrula are everywhere the same there is a perfect radial symmetry about this axis.

Since the gastrula, though usually in a considerably modified form, is common to all animal types and forms the starting point for the divergence of the various major groups, it is important to determine what its real significance is.

From the egg through the blastula to and including the gastrula there is a direct geometrical continuity leading to the formation of a body radially symmetrical about a single axis. The logical termination of such development would be the formation of an animal type in which the gastrula axis persists to the adult and the body of the adult is radially symmetrical about it.

If the facts presented by a study of embryology are significant in indicating the phylogeny of animals, it is clear that the last common ancestor of all the bilaterally symmetrical animal types was a radially symmetrical form, or a sort of adult gastrula.

There are two such animal forms. In one of these, the sponges, the body consists of a community of cells imperfectly integrated and showing relatively little devision of labour or unified life. The sponges continue to grow throughout life, and their increase is always radial.

In the other, the coelenterates, the body is a distinct unit of more or less definite size with a gastrovascular cavity and a well developed muscular system. Growth in the coelenterates as in the sponges is continuous throughout life; but since the complexity of the organization imposed a definite maximum size on the individuals, the growth impetus results in the continued formation of new individuals which bud off from those preceding, typically resulting in an arborescent or mass colony comparable to that seen in the phanerogams. While in many coelenterates the budded individuals become free, and in some

there is no budding at all, there can be no doubt that fundamentally the coelenterates are phanerogam-like colonial animals.

There is nothing that can be assumed to connect the sponges with any other animal type except, perhaps, with certain of the Protozoa. It is evident that the gastrula stage in the development of the bilateral animals cannot represent any sponge-like progenitor. It is possible, however, to interpret the bilateral animals in terms of the colonial coelenterate. Indeed, it is not possible to interpret them in any other way, for any other explanation of their origin would assume the presence of a fundamental bilateral tendency, an unknown and undeterminable variable not common to all animal types.

If a colonial coelenterate with radially symmetrical polyps should develop a persistent defect in the ontogeny whereby the units became bilaterally symmetrical, bilateral animals of four main types would at once appear:

1. Bilateral animals in the form of a linear more or less unified colony.
2. Bilateral animals in which the colony formation was inverted, the budding of the new elements taking place within the original unit.
3. Bilateral solitary animals each representing a dissociated coelenterate unit; and
4. Bilateral animals with the colonial habit, though independent of each other.

These four main types, between which there would be numerous intergrades, all represent definite types occurring among the coelenterates themselves, and therefore none of them can be said actually to represent anything new in animal structure other than the novelty consequent on the developmental defect which resulted in the loss of the radial and the assumption of the bilateral body form.

Among the animals of today all four of these main types are represented:

1. The tape-worms or segmented cestodes form a linear colony of continuous growth so like a partially unified strobila as to leave little doubt of the fundamental similarity of type. The scolex of the cestodes is radially symmetrical, but the proglottides are strongly flattened and bilaterally symmetrical, though the difference between the dorsal and the ventral surface is but little marked.

2. The flukes have a peculiar development which is essentially similar to strobilization, except that the buds are formed within the original unit instead of in a linear series.

In those coelenterates with division of labour the polyps are of three sorts, (*a*) nutritive, or sac-like, (*b*) reproductive, and (*c*) excretory, or "defensive." If in strobilization of the fluke type buds of each of these sorts were formed internally, this would furnish the elements necessary for the creation of the so-called coelome, which is divided into three parts, (*a*) the perivisceral, or sac-like, (*b*) the gonadial, and (*c*) the excretory or nephridial.

The flukes and their allies always retain distinct traces of radial symmetry, especially in their digestive system and in the arrangement of their nerves.

3. The turbellarians and nematodes are bilateral solitary animals, the individuals each comparable to a single coelenterate polyp. All of them show distinct traces of radial symmetry in their nervous system, and the turbellarians also in their digestive system.

4. Such turbellarians as *Microstomum* are single animals each comparable to a single coelenterate polyp; but they divide in such a way as to produce chains of similar attached animals each of which is independent of the others and not a part of a more or less unified entity as in the case of the proglottides of the tape worms.

The cestodes, the flukes, the turbellarians and *Microstomum* are all flat worms and all more or less closely related to each other. They all retain to a very considerable degree traces of radial symmetry and of other coelenterate features. Being intermediate between radially symmetrical and bilaterally symmetrical types it requires very little imagination to assume that they represent the four original types into which the coelenterates disintegrated upon the appearance of that developmental defect which resulted in bilateral symmetry.

If the preceding suppositions are logical it is evident that the so-called evolution of the bilateral animals cannot be evolution in the sense of the progressive development of higher types from lower, but instead must have been a recombination and reassortment of the four diverse features characteristic of the four types into which the radially symmetrical colonial coelenterate type disintegrated. In other words the so-called evolution of animals is in reality a convergence toward a common centre from four equidistant points, and the progressive economic efficiency does not indicate any real phylogenetic progress, but results merely from a more and more intimate intermingling of, and a progressively better balance between, the main features indicated by the tape worms, flukes, turbellarians and *Microstomum* standing at the four corners of the original square.

The four corners of this square are marked by four animal types which are closely related to each other, yet at the same time are fundamentally distinct. One of them indicates the commencement of the segmented body; another shows the beginnings of the coelomic structures; a third is simple, with no indications of segmentation or of a coelome; while the fourth is a colonial form of the third.

From these four points there would proceed evolution of two kinds.

Each type would give rise to all economically possible variants through a process of continuous development which could be approximately represented by a branching tree-like figure; but all of the the different forms arising in this fashion would fall strictly within limits of its proper type.

As examples of such evolution may be mentioned the insects, crustaceans, molluscs, annelids, etc., within which groups all the included types may be more or less successfully represented as branches of a tree-like figure at the base of which lies a generalized or primitive form; but this and all the others however much they may diverge in details of structure always agree in their fundamental features.

Since they all have arisen from the same colonial coelenterate-like ancestor which has, so to speak, exploded into four different types, each of these four points represents an animal complex in a state of unstable equilibrium; for each one has latent within it the fundamental features of the other three.

Such an unstable equilibrium, in effect an explosive force, would presumably result in a sudden readjustment of the somatic balance whereby intermediate types would appear, one between each two of the four corners (fig. 1); while these intermediate types, each a distinct re-creation and not genetically connected with either of its neighbors, would show a distinct economic advance, this economic advance would in no way represent real evolutionary progress, for it would be merely the result of the combination of the advantages inherent in the structure of the types on either side.

Thus there would suddenly appear, quite without apparent ancestry, (1) segmented animals, like the tape-worms, with a coelome, like the flukes; (2) unsegmented animals, like the turbellarians, with a coelome like the flukes; (3) solitary unsegmented animals without a coelome, like the turbellarians, but with abundant asexual reproduction, like *Microstomum:* and (4) segmented animals without a coelome, like the tape-worms, but less unified and without the continuous loss of the units, as in *Microstomum.*

All four of these intermediate types actually occur. All are entirely and widely distinct from each other, and show no demonstrable intergradation with any of the remaining animal types, each occupying a markedly isolated position. Three of the four are extraordinarily rich in genera and species; the last and least successful is represented by two closely parallel and non-intergrading forms which are identical with regard to the features with which we are concerned, but differ in all others. One of the first three is the only major animal group which has not persisted to the present time.

The segmented animals with a coelome are the annelids; the unsegmented animals with a coelome are the priapulids and sipunculids;

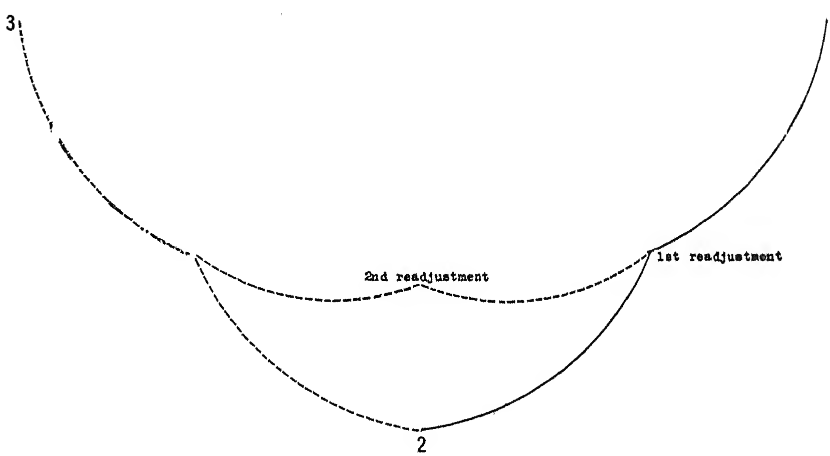

Fig. 1. Showing the first and second readjustments.

the solitary acoelomate animals with abundant asexual reproduction are the rotifers; and the acoelomate animals forming colonies of separate individuals are undoubtedly the graptolites (fig. 3).

Through this readjustment as just described each of the new animal types would combine the features of two of the original types. But since in each of these new types two of the four chief features are absent, there would still exist a condition of unstable equilibrium as compared with the colonial coelenterate-like ancestor.

A second readjustment of the same nature as the first would be inevitable by which four animal types would appear in line with the first, but combining the characters of the intermediates in the second series (fig. 1).

Three such intermediates (fig. 3) seem to be clearly indicated in the polyzoans, colonial and not at all or very imperfectly coelomate, between the rotifers and the graptolites; the arthropods, with a segmented body like that of the annelids, but divided into two or three units showing division of labour (in the insects one controlling and directing, one locomotor, and one performing the digestive, reproduc-

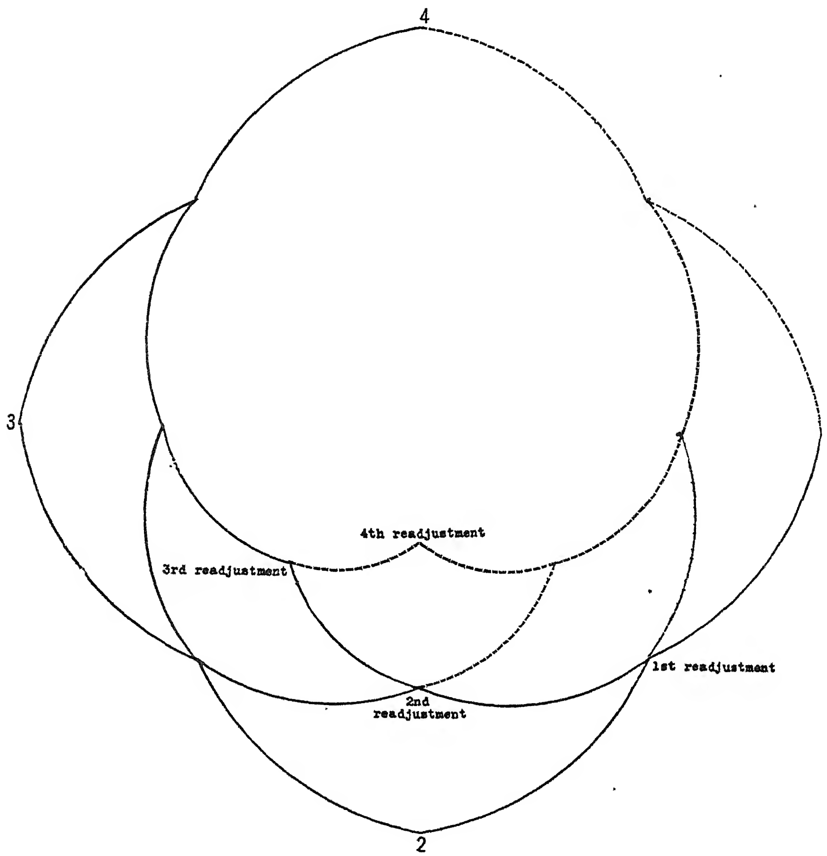

Fig. 2. Showing the first to the fourth readjustments.

tive and other vital functions) after the graptolite or polyzoan fashion, with a poorly developed coelome, with abundant traces of asexual reproduction (polyembryony, parthenogenesis, fragmentation of larvae, etc.), with a marked tendency to form (as in the ants) polyzoan-like colonies with division of labour among the (dissociated) units, and sometimes even forming dendritic colonies (as in *Thompsonia*); and the molluscs, always solitary, like the priapulids and sipun-

culids, with a highly developed coelome, and with traces of segmentation suggesting the annelids. The fourth group should be solitary with an indication of colonial structure and a coelome, but without segmentation. It is possible to place the nemerteans here by assuming their imperfect segmentation to be of the *Microstomum* and not of the tape-worm type.

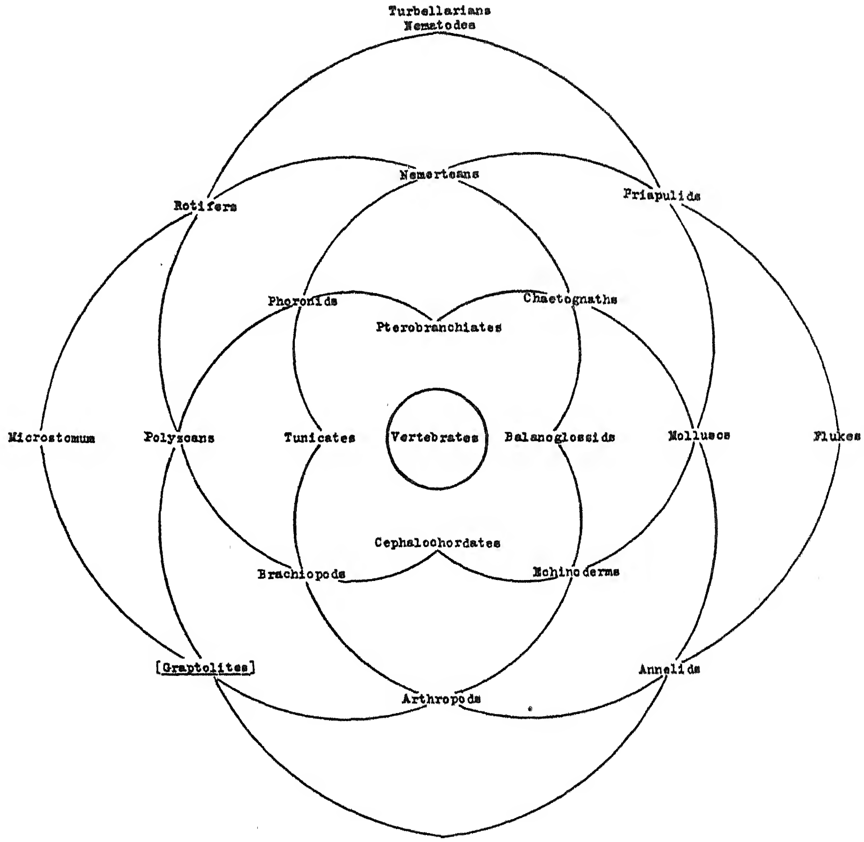

Fig. 3. Showing the development of the various animal types above the coelenterates.

There is still a condition of unstable equilibrium, for in each of these four groups one of the original elements is lacking. A third readjustment (fig. 2) would be necessary to recombine all the main features characteristic of the original four types.

Four animal groups (fig. 3) appear to be the result of such a readjustment. The echinoderms combine a reduced body consisting of five half segments of the arthropod type with a highly perfected coe-

lome; the chaetognaths suggest a relationship with the molluscs, and also with the nemerteans; the phoronids suggest a relationship with the polyzoans, but have a well developed coelome, and the colonial habit is reduced to the budding off of new individuals; and the brachiopods suggest both the polyzoans and the barnacle-like arthropods.

While by this third readjustment all the four original features are recombined in each animal type, the balance between them is imperfect, for the influence of one of these features in each case is greatly overshadowed by the influence of the other three.

A fourth readjustment (fig. 2) would correct this imperfect balance and result in the appearance of four animal types all very much alike.

There are four types which appear to belong here (fig. 3), the tunicates, the cephalochordates, the balanoglossids and the pterobranchiates. The tunicates seem to be in line with the polyzoans, while they also suggest both the brachiopods and the phoronids; the cephalochordates clearly stand in the cestode-arthropod line, and at the same time show indubitable affinities with the echinoderms; the balanoglossids, with no trace of asexual reproduction, may be considered in line with the flukes and molluscs and between the chaetognaths and echinoderms; while the pterobranchiates seem to fall between the chaetognaths and the phoronids.

These four closely related types resulting from this fourth readjustment are each slightly excentric; but they are so close to each other that a fifth readjustment would presumably give a final perfected type in which at last all of the four chief features of the original types would be reunited in the economically most perfected form.

The vertebrates appear to occupy this central position (fig. 3). In them we are able to recognize the segmentation of the cestodes, annelids, and cephalochordates, combined with the coelomic structure first indicated in the flukes, both enclosed in the undivided body of the turbellarians. Unless the limbs can be compared to budded units recalling certain highly reduced and specialized units in tunicate or polyzoan colonies, the influence of the feature represented by *Microstomum* seems to have disappeared.

In the course of the various readjustments which culminated in the formation of the vertebrates numerous secondary features, such as visual and other sense organs, appendages of different kinds, diverticula and other outgrowths from the enteric canal, chitinous and calcareous skeletons, etc., all of which exist in the coelenterates and in one or other of the four types derived immediately from them, became enormously developed and specialized in correlation with the

increasing bodily efficiency resulting from the recombinations. But if the analysis of the origin of the various animal types just given is an approximately true exposition of the facts, the vertebrates, in spite of their wonderful complexity of structure and their very high degree of efficiency, represent nothing more than the final recombination of characters already occurring in the colonial coelenterates which were widely dissociated at the inception of bilateral symmetry.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

877TH MEETING

The 877th meeting was held in the Cosmos Club Auditorium on Saturday, January 27, 1923. The meeting was called to order at 8:15 P.M. by President WHITE with 29 persons in attendance.

Mr. G. T. RUDE presented a paper on *Instruments and methods for the observation of tides*. The paper was illustrated with lantern slides, and was discussed by Messrs. LAMBERT, BOWIE, PAULING, HUMPHREYS, HAWKSWORTH, FARIS, LITTLEHALES, and TUCKERMAN.

Author's abstract: A continuous record of the rise and fall of the tide is necessary in connection with a number of engineering and scientific problems.

The simplest method of tidal observation consists in observing the changing height of the water as noted on a fixed vertical staff. From this it was but a step to devising some mechanical means for recording automatically the rising and falling of the surface of the sea.

The earliest automatic tide gauge of which we have record was devised by an English civil engineer, Henry R. Palmer, and is described in the Philosophical Transactions of the Royal Society, London, for the year 1831.

Of the automatic tide gauges, two classes may be recognized: (1) those in which the changes in elevation are shown in the form of a curve; (2) those in which the height of the water at definite intervals is shown by means of figures, or the so-called printing gauges. The various forms of the tide gauges in use were shown by means of slides and attention called to the distinguishing features.

Special attention was directed to a new type of automatic tide gauge recently developed in the office of the Coast and Geodetic Survey for use of hydrographic parties in the field. In designing this instrument the objects sought were ease of installation and minimum size commensurate with the desired accuracy. The gauge is about 10 inches long and 9 inches high. The clock is placed inside the cylinder carrying the cross-section paper on which the curve of the tide is drawn. No counterpoise weight is used, a coiled spring taking the place of the weight. The float well is ordinary 3½ inch stock iron pipe and in addition to serving as a float, it acts as a support for the gauge. No platform is necessary for the installation of this gauge, which may be lashed to a pile on a bar or to net stakes in bays or rivers. A metallic cover furnishes the only shelter necessary.

Messrs. G. W. VINAL and G. N. SCHRAMM presented a paper on *The tarnishing and detarnishing of silver.* The paper, which was illustrated by lantern slides, was presented by Dr. VINAL and discussed by Messrs. PAULING, HAWKSWORTH, HUMPHREYS, LAMBERT, GISH, HEYL, and SHOWEY.

Author's abstract: The tarnish observed on silver is ordinarily the sulphide. It was found that hydrogen sulphide causes tarnishing of silver when moisture is present, and particularly when sulphur dioxide is also present.

The electrolytic method for detarnishing silver is based upon the fact that the silver immersed in a solution of salt and soda and in contact with and electro-positive metal forms a cell in which the hydrogen passing to the silver reduces the sulphide, liberating hydrogen sulphide. The reduced silver is left upon the surface in the moss condition.

The tarnishes formed a definite color scale which may be used to estimate the extent of the tarnish. The colors are as follows: Yellow, red, purple, blue, blue-green, gunmetal, black.

Experiments were made to study the tarnishing of silver in solutions and gas atmospheres, and conditions for establishing a standard tarnish were determined. The thickness of the tarnish film was found to range from 0.18 to 0.36 microns, which is about 2 per cent of the thickness of the silver plating. Sterling silver tarnishes more readily than pure silver. Tarnishing is accelerated by the presence of moisture, sulphur dioxide and certain films on the surface of the silver, such as alkali and soap films. The tarnishing of silver may be retarded by the action of several reagents.

Comparisons between various electrolytic devices for detarnishing were made. There is practically no loss of silver by the electrolytic method of cleaning, unless the moss silver is present in objectionable amounts. Silver losses are appreciable when the cleaning is done by abrasives and cyanide solutions. The potential differences between the silver and the various metals used for the cleaner were determined.

Adjournment at 10:01 P.M. was followed by a social hour.

J. P. AULT, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

At the Physics Club, Bureau of Standards, on February 26, Dr. W. F. MEGGERS spoke on *Line structure in complicated spectra.*

The subject was introduced by a general outline of the earlier known regularities in the spectra of the chemical elements beginning with the Balmer series of hydrogen and followed by the types of series found in the relatively simple spectra characteristic of the elements in the first three columns of the periodic classification. There are four general types of series, principal, sharp, diffuse, and fundamental, each of which may be represented by single, double, or triple spectral lines. Doublets, triplets, and more complex structures are explained as arising in a multiplicity of P, D, and F energy levels between which electron transitions take place. The S term is generally single. In addition, certain inter-combinations of these series may represent observed spectral lines.

The quantum theory assigns azimuthal quantum numbers 1, 2, 3, and 4 respectively to the four general types of series and restricts inter-combinations to those involving a change of only one unit in quantum number. The sum of azimuthal and radial quantum numbers determines the position (term number) of a line in a series. An "inner quantum number" is asso-

ciated with the multiple levels representing each P, D, or F term and composite doublets and triplets containing so-called satellites are explained by changes of plus one, minus one, or zero in the inner quantum number. The same theory attempts to account for a new type of regularity shown by groups of lines called "multiplets" which have recently been found in the complicated spectra of manganese, chromium, and molybdenum. In the arc spectrum of manganese, for example, groups of 9, 13, or 15 lines are apparently explained by changes in inner quantum numbers assigned to 3P, 5D, and 7F levels when the 9, 13, and 15 line multiplets represent intercombinations of PD, DD′, and DF terms respectively. In its present state, however, the theory is unable to predict the exact character or location of regularities in unclassified spectra.

The Pick and Hammer Club met on Saturday evening, February 24, in the Director's room of the Geological Survey. The *Foreign situation of petroleum* was discussed by E. De Golyer, and the *Domestic situation of petroleum*, by G. B. Richardson.

A party of observers from the U. S. Coast and Geodetic Survey is at work in southern California to determine the distance between Mount Wilson and San Antonio Peak. The distance between these two peaks is about 20 miles, and a base approximately parallel to the line joining them and having a length of approximately 20 miles has been located in the valley or plains just to the south of the two peaks. The work involved in this project consists of observations for triangulation and trionometric leveling, the measurement of the base line with an accuracy not less than one part in a million, the determination of the deflection of the vertical in both the meridian and the prime vertical, and some precise leveling. Each section of the base will be measured at least four times with different tapes in order to secure this high degree of accuracy.

The Division of Physical Anthropology, U. S. National Museum, has received casts of the two recently discovered ancient Obercassel skulls with parts of the skeletons. The Museum has now very nearly a complete set of casts of early human remains, and with one or two exceptions they are all first-hand casts made directly from the originals, which enhances their value.

Miss Florence Bascom, Professor of Geology at Bryn Mawr College, is spending the winter months in Washington completing her work for the U. S. Geological Survey.

Mr. S. R. Capps has returned from private geologic work abroad to duty as geologist in the U. S. Geological Survey.

Mr. E. T. Hancock, formerly geologist on the U. S. Geological Survey, now employed by the Standard Oil Company in Roumania, visited Washington in the latter part of February.

Mr. F. E. Matthes of the U. S. Geological Survey gave an illustrated address on March 5 before the New York Academy of Sciences on the subject of *The evolution of the Yosemite Valley.* He also spent a day at the American Museum of Natural History inspecting the new large relief model of

the Yosemite Valley that is being prepared under the direction of Dr. E. O. Hovey.

Dr. Charles Moon of Cornell University, began work at the Bureau of Standards on February 6, in the Section of Induction and Capacity, Electrical Division.

Dr. Edward W. Morley, emeritus professor of chemistry at Western Reserve University, and one of the most famous American scientists, died on February 26 at Hartford, Connecticut, in his 86th year. He was born at Newark, New Jersey, January 29, 1838. He was educated at Williams College and received honorary degrees from that university and also from Western Reserve, Lafayette, Pittsburgh, Wooster, and Yale, also holding the professorship at Cleveland Medical College from 1873–88. Among notable prizes awarded to Professor Morley were the Davy Medal of the Royal Society in 1907, Cresson Medal of the Franklin Institute in 1912, and the Gibbs Medal in 1916. His work on the atomic weight of oxygen and the densities of oxygen and hydrogen is known to all chemists, while the Michelson-Morley experiment is one of the most fundamental in physics. Professor Morley was a member of the Academy and of many national and foreign chemical and physical societies.

Dr. F. C. Weber, for many years chemist in the Bureau of Chemistry, U. S. Department of Agriculture, has resigned to accept a position with the Fleischmann Company, New York, N. Y.

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BOTANY.—*New composites from Salvador.* S. F. BLAKE, Bureau of Plant Industry.

The extensive botanical collections made in Salvador in 1921–22 by Mr. Paul C. Standley of the U. S. National Museum contain three new species of Asteraceae, which are described below. The new genus *Rensonia* is the first known Central American representative of a small group of the subtribe Melampodinae which has hitherto consisted of the medium-sized genus *Silphium* of the United States, the monotypic *Schizoptera* of Ecuador, and the small genus *Moonia* of Australia, India, and Ceylon. The new species of *Zexmenia* is also interesting from a geographical point of view, as its nearest relative is a Brazilian species.

Vernonia standleyi Blake, sp. nov.

Shrubby, 1 to 1.6 meters high, branched above, the branches sometimes supra-axillary; stem stoutish, sometimes zigzag, grayish-barked, striatulate, sessile-glandular, puberulous above, glabrate below; leaves alternate; petioles naked, puberulous, 2 to 5 mm. long; leaf blades elliptic-oblong or elliptic, 6 to 9 cm. long, 1.3 to 3 cm. wide, acuminate, acutely or acuminately cuneate at base, subentire or serrulate with about 15 pairs of small acute teeth, firm-papery, above dotted with sessile yellowish glands, finely puberulous, glabrate except along the veins, beneath paler green, gland-dotted and not densely short-pilose with flexuous hairs, more or less glabrescent except along the nerves, featherveined, the lateral veins about 6 pairs, prominulous beneath, the veinlets few and prominulous beneath; heads discoid, 5-flowered (rarely 4-flowered), 8 mm. high in fruit, numerous, sessile or subsessile in dense rounded clusters 1 to 3 cm. thick at tips of branches and stem and on short axillary branchlets; involucre 5 or 6-seriate, graduate, 4.5 mm. high, the outermost phyllaries ovate, the middle ones ovate-oblong, the innermost linear and deciduous, all indurate and whitish, greenish along costa above, obtuse to acutish, the innermost glandular on back and sparsely arachnoid-ciliate, thin-margined, the others glandular and more or less villous dorsally and densely arachnoid-ciliate; corollas whitish (?), hispidulous especially on tube, 5.5 mm. long (tube 2.5 mm., throat 0.5 mm., teeth 2.5 mm.); achenes

somewhat obcompressed-turbinate, 2.5 mm. long, 7-ribbed, whitish, densely ascending-pilose, bearing a short glabrous collar at apex; pappus 2-seriate, white, copious, the outer aristae numerous, 0.8 mm. long, the inner 3.5 mm. long.

Type in the U. S. National Herbarium, no. 1,135,594, collected on brushy hillside near Santa Ana, Department of Santa Ana, Salvador, altitude 655 to 800 meters, January 8, 1922, by Paul C. Standley (no. 19703).

ADDITIONAL SPECIMENS EXAMINED: SALVADOR: Pine forest, vicinity of Santa Ana, altitude 655 to 900 meters, January 28 to 30, 1922, *Standley* 20413.

A member of the section *Eremosis*, nearest *Vernonia triflosculosa* H.B.K., but distinguished by its usually 5-flowered heads, its densely arachnoid-ciliate phyllaries (the outermost ovate, not suborbicular or suborbicular-ovate as in *V. triflosculosa*), and the much more conspicuous glabrous collar at apex of achene. The species is abundant on the slopes along the railroad in the Department of Santa Ana, forming large masses, which are conspicuous because of the white pappus of the closely crowded heads.

Rensonia Blake, gen. nov.

Shrub; leaves opposite, ovate, slender-petioled, large, serrate, scabrous; heads small, heterogamous, radiate, in terminal cymose panicles, the rays pistillate, fertile, the disk sterile; involucre turbinate-campanulate, 2-seriate, equal or subequal, the phyllaries 8 or 9, oblong-obovate, erect, indurate below, thick-herbaceous above; receptacle small, flat; outer pales flattish, the inner narrow, complicate; pistillate flowers about 8, about 1-seriate, their corollas ligulate, yellow, apparently small; disk flowers hermaphrodite, sterile, about 20, their corollas tubular, with slender tube, much longer cylindric-funnelform throat, and 5-toothed limb; anthers with minutely sagittate bases and ovate terminal appendages; style (hermaphrodite flowers) undivided, above thickened and hispidulous; ray achenes obovate, obcompressed, epappose, not at all coherent with the subtending phyllaries or the pales of the disk, 2-winged, the wings submembranous, narrow, nerved, entire or lacerate above, prolonged above the achene into two triangular lacerate teeth; disk achenes inane, elongate-clavate, trigonous, wingless, their pappus a short, thick, entire, hispidulous crown, with or without a single short, slender awn.

This genus is named for Dr. Carlos Renson, who has been connected with the Salvador Department of Agriculture for more than thirty years, and whose botanical collections, a series of which is in the U. S. National Herbarium, are the most extensive made in Salvador prior to Mr. Standley's trip. It is a member of the Heliantheae-Melampodinae, to be inserted between *Silphium* L. and *Schizoptera* Turcz. The former genus, no species of which is known south of the United States, consists of tall herbs with large, broadly campanulate or subglobose heads and 2 or 3-seriate rays. The monotypic genus *Schizoptera* Turcz.,[1] known only from Ecuador, is an herb with a campanulate involucre of membranous-herbaceous outer and

[1] See Blake, Hook. Icon. Pl. **31:** *pl. 3058.* 1916, and Contr. Gray Herb. n. ser. **52:** 34. 1917.

membranous-scarious inner phyllaries, biseriate rays, and disk achenes epappose or with 2 awns but no corona.

Rensonia salvadorica Blake, sp. nov.

Shrub 2 to 5 meters high, oppositely branched; stem slender, scabrid-strigillose, gray-barked, subterete, striatulate, the younger branches angulate; petioles naked, strigillose, 2.5 to 8.5 cm. long; leaf blades ovate, 9 to 26 cm. long, 3.5 to 10 cm. wide, acuminate and usually somewhat falcate, acutely cuneate (sometimes abruptly so) at base, serrate except toward base and at apex with about 45 pairs of depressed acutely callous-tipped teeth, thin, above deep dull green, rather densely and very harshly hispidulous with mostly deciduous hairs with lepidote-tuberculate persistent bases, beneath slightly lighter green, evenly short-strigose with slightly harsh hairs and along the veins sparsely hispid or hispidulous, triplinerved above the base and loosely prominulous-reticulate beneath; heads (flowers fallen) 6 to 7 mm. high, about 5 mm. thick, about 20 in a terminal, ternately divided, convex, cymose panicle 4 to 7 cm. wide, it's branches densely strigillose, the bracts very small, the slender pedicels 1 to 2 cm. long; involucre 5 to 7 mm. high, strigillose, the firm thickish phyllaries oblong-obovate, 1.5 to 2 mm. wide, acute, callous-tipped, 3 or 5-nerved; ray flowers scarcely seen; disk corollas (over-mature) 5 mm. long (tube 1 mm., throat 3.2 mm., teeth ovate, 0.8 mm.); pales narrow, firmly scarious, acuminate, strigillose, about 5 mm. long; ray achenes broadly obovate, 5.2 to 5.8 mm. long and 2.5 to 2.8 mm. wide (including wings), the body obovate, blackish, 4 mm. long, 2 mm. wide, nerveless, hispidulous toward apex outside, nearly glabrous inside, the wings erect-nerved, continued into triangular teeth, the teeth and sometimes the upper part of the wings lacerate and minutely ciliolate; disk achenes 3.2 to 3.5 mm. long, hispidulous toward apex, the corona 0.3 mm. high, the awn 0.7 to 1.2 mm. high.

Type in the U. S. National Herbarium, no. 1,135,663, collected in the wooded ravine of the Río Ataco, among mountains back of Ahuachapán, Department of Ahuachapán, Salvador, altitude 800 to 1000 meters, January 10, 1922, by Paul C. Standley (no. 19783).

ADDITIONAL SPECIMENS EXAMINED: SALVADOR: Along stream, vicinity of Ahuachapán, January 14, 1922, *Standley* 19964. In forest, Sierra de Apaneca, region of Finca Colima, Department of Ahuachapán, January 17 to 19, 1922, *Standley* 20090.

This shrub bears the vernacular names "canilla," "tatascamillo," and "vara de zope." Unfortunately all three collections are too mature to show the character of the flowers well. A single imperfect ray adhering to one of the heads was yellow, nearly linear, and appeared to be scarcely longer than the style branches. All the flowers are probably yellow. The species is very similar in general appearance to *Perymenium strigillosum* (Robins. & Greenm.) Greenm.

Zexmenia iners Blake, sp. nov.

Erect or decumbent annual, 25 to 50 cm. high, freely branched; stem slender, densely spreading-hirsutulous with somewhat uncinate hairs and sparsely hispid with straight wide-spreading hairs, glabrate below; leaves opposite essentially throughout; petioles 2 to 10 mm. long, hirsutulous and hispid-ciliate; leaf blades of the stem leaves ovate or oblong-ovate, 2.5 to 7 cm. long, 1.2

to 3.3 cm. wide, acute or acuminate, acutely cuneate at base, depressed-serrate (teeth 4 to 8 pairs), thin, evenly but not densely uncinate-hirsutulous on both sides, evenly tuberculate-hispid on surface above, hispid chiefly on the veins beneath, triplinerved well above the base, green on both sides; branch leaves smaller; heads solitary in the forks of the stem and at tips of branches, in flower slender, about 6 mm. wide, in fruit hemispheric, about 1 cm. wide; peduncles slender, pubescent like the stem, 1 to 5 cm. long; disk in anthesis 7 mm. high, 3 mm. thick; involucre 2-seriate, obgraduate or subequal, 6 to 8 mm. high, the phyllaries few (about 6), the outer lanceolate or narrowly oblong-lanceolate, 1.5 to 2 mm. wide, obtuse or acutish, herbaceous for the upper half of their length, pale and usually 1-ribbed below, erect, pubescent like the stem and hispid-ciliate, the inner similar but usually shorter and broader, with shorter usually acute herbaceous tips; rays 3 to 5, fertile, orange yellow, the lamina suborbicular, 3 to 3.5 mm. long, 2.8 to 3 mm. wide, bilobate with sometimes bidentate lobes, densely hirsutulous on back on the two chief nerves; disk flowers about 5 to 7, orange yellow, puberulous and ciliolate on the teeth and with a puberulous ring at base of throat, 3.8 to 4.5 mm. long (tube tubular-funnelform, 1.5 to 2 mm., throat funnelform, 1.5 to 1.8 mm., teeth ovate, 0.7 mm.); pales scarious, obtuse, wing-keeled to below the apex, 7 mm. long; ray achenes (with wings included) broadly oval-obovate, 5.5 mm. long, 3.5 to 4 mm. wide, the wings about 1 mm. wide, short-ciliate and erose, prolonged above the achene as rounded ears, not adnate to the pappus cup, often purplish-spotted, the body of achene obovoid, obcompressed, 4 mm. long, 1.5 mm. wide, blackish, tuberculate-hispidulous especially on midline, with a conspicuous callous appendage on each face at base; pappus a short-stipitate, lacerate, squamellaceous corona about 1.5 mm. high (including the neck), and 1 to 3 awns 2 mm. high or less, or the latter sometimes obsolete; disk achenes similar but compressed, the pappus awns 2, unequal, 1 to 1.5 mm. long.

Type in the U. S. National Herbarium, no. 1,139,183, collected in sand along a stream, near Armenia, Department of Sonsonate, Salvador, April 18, 1922, by Paul C. Standley (no. 23498).

OTHER SPECIMENS EXAMINED: SALVADOR: In hedgerow, vicinity of San Salvador, altitude 650 to 850 meters, December 20, 1921, to January 4, 1922, *Standley* 19414. Wet soil along stream, vicinity of San Salvador, March 30 to April 24, 1922, *Standley* 23300. Wet thicket, vicinity of Santa Emilia, Department of Sonsonate, altitude 135 meters, March 22 to 25, 1922, *Standley* 22259.

Among North American species *Zexmenia incrs* is nearest *Z. hispida* (H.B.K.) A. Gray and *Z. longipes* Benth., from both of which it differs in its annual root, smaller heads on much shorter peduncles, and tiny, roundish rays. *Z. rudis* Baker of Brazil, the only annual species of the genus hitherto known, is more closely related to *Z. iners*, but has considerably larger leaves and rays.

ENTOMOLOGY.—*New genera and species of sucking lice.* H. E. EWING, Bureau of Entomology, U. S. Department of Agriculture. (Communicated by S. A. ROHWER.)

In this paper are described four new genera and three new species of Anoplura, or sucking lice. The material upon which these genera

and species are based is a part of the collection of sucking lice of the United States National Museum, and in this museum the types are catalogued and deposited.

Proenderleinellus, gen. nov.

Second abdominal segment not provided with a pair of ventral tubercle-bearing plates. Number of pairs of abdominal pleural plates seven. Antennae without any tooth-like processes; and head without paired plates situated on ventral surface between the antennae. First and second pairs of legs subequal and smaller than the last pair. Tibiae of first and second legs broadened distally and tarsi of the same legs broadened proximally, thus forming with the claws, clasping structures; first and second tarsal claws simple. Parameres of male genitalia long, arm-like.

Type of genus: Proenderleinellus africanus, new species.

This genus is related to *Hoplopleura* Enderlein on the one hand and to *Microphthirus* Ferris and *Enderleinellus* Fahrenholz on the other. Only the type species is included.

Proenderleinellus africanus, sp. nov.

Forehead fully twice as broad as long; postantennal region of head about as broad as long and with two pairs of dorsal setae, an anterior, minute pair just behind the antennae and a large posterior pair at the posterior angles. Antennae about as long as head; second segment the longest. Thorax with two pairs of dorsal setae, a small, very short, spine-like pair just inside and slightly in front of the thoracic spiracles and a very large, long, curved pair just inside and slightly posterior of the spiracles. Anterior process, or manubrium, of sternum with parallel sides; sternum also with a posterior process extending between the posterior coxae. Abdomen with a lateral area both above and below without setae and between this lateral area and the pleurae on each typical abdominal segment are situated two setae. Typical pleural plates with two small, pectinate, posterior lateral lobes, and between them are situated the two, large, subequal, straight pleural setae. In typical pleural plates the stigmata is situated near the posterior margin. Genital armature of male with broad, parallel-sided, distally emarginate basal plate; long curved parameres; and stout, heavily chitinized pseudopenis. Posterior legs considerably enlarged, but not enormous, their expanded claws simple. Length of male, 1.42 mm.; width of male, 0.57 mm.

Type host and type locality: From *Thryonomys gregor pusillus* (U.S.N.M. 184180), taken at Majiya-Chumvi, British East Africa.

Type.—Cat. No. 23760, U.S.N.M.

Description based on a single male, but it is a perfect specimen.

Pterophthirus, gen. nov.

Antennae without lateral processes and essentially the same in the two sexes. Typically each abdominal segment of female provided dorsally with three transverse rows of setae. Second sternal plate of abdomen not divided medially into two large rounded plates. Second pair of pleural plates not lobed, but enormous and wing-like and each bearing the small, spine-like pleural setae near its dorsal margin.

Type of genus: Hoplopleura alata Ferris.

This genus is established for the reception of the peculiar Octodont infesting species, *Hoplopleura alata* Ferris and *H. audax* Ferris. The great modification of the second pair of pleural plates, not so much in size but in type, is the outstanding feature in this genus. This modification has resulted in the peculiar shifting of the position of the pleural setae so that they have become dorso-marginal.

Eulinognathus americanus, sp. nov.

Forehead very short and cone-shaped; postantennal region of head as broad as long. Antennae equal to the head in length; first segment broader than long, second segment of about equal breadth and length. Thorax about as broad as long; sternum without anterior process between first coxae but with a posterior process which extends between the third coxae for a part of its length. Abdomen much longer than broad. Typical pleural plates with spiracular opening slightly in front of the middle, with two cusp-like posterior lobes and short, stumpy, truncate pleural setae, scarcely half as long as the pleural plates themselves. Abdominal setae curved near their bases, flattened and parallel-sided beyond and truncate distally, each being about as long as the abdominal segment on which it is situated. Gonopods of female short and stumpy and with a few spinous setae. Second legs intermediate between first and third. Claw of third leg neither toothed or appendiculate. Length of female 0.95 mm.; width of female 0.39 mm.

Type host and type locality: From *Ctenomys brasiliensis* (Cat. No. 3252, 1939 U.S.N.M.) taken at Salade River, Paraguay.

Type.—Cat. No. 23761, U.S.N.M.

The genus to which this species belongs has been represented in the past by only two species, one of which came from a host of the rodent family Pedetidae and the other from the rodent family Dipodidae. The host of the new species here described belongs to the rodent family Octodontidae. Only a single female specimen taken.

Phthirpediculus, gen. nov.

Antennae long and distinctly five-segmented. Thorax and abdomen distinctly separated; segments two, three and four of abdomen distinct and bearing its pair of spiracles in the normal lateral position; abdomen with well developed pleural plates on segments three to eight and without lateral lobes. Typical abdominal segments provided with a single transverse row of setae both above and below. Genital armature of male with a basal plate composed of two distally united, parallel rods; with large, more or less blade-like parameres; and with conspicuous, heavily chitinized pseudopenis. First pair of legs very small, the other two pairs much enlarged; all legs attached to thorax in a ventro-lateral position.

Type of genus: Phthirpediculus propitheci, new species.

This genus, represented only by the new species here described, is intermediate between *Pediculus* Linnaeus and *Phthirus* Leach, having the long abdomen with pleural plates as in *Pediculus*, but the small anterior legs of *Phthirus*.

Phthirpediculus propitheci, sp. nov.

Forehead provided with posteriorly directed, spine-like tubercles both above and below; postantennal region of head with two small spine-like tubercles behind the insertion of each antenna. Eyes with poorly developed corneas, situated at the anterior angles of temples. Antennae longer than the head; first segment with four small ventral tubercles; second segment with one dorsal and two ventral tubercles; third segment with extended anterior margin, which causes antenna to become geniculate, the bend being between third and fourth segments; last segment with sensory pit on posterior margin. Thorax broadest at its posterior margin, where it joins the abdomen. Each posterior angle of thorax with a conspicuous spine-like tubercle. Typical pleural plates of abdomen bilobed and with the contained stigmata near the front margin. Genital armature of male with a basal plate composed of two parallel chitinous rods which are united distally; with almost straight parameres, inwardly thickened, outwardly coming to a knife-edge and posteriorly each ending in a small, blunt hook; pseudopenis very large, consisting of a basal rod and a distally articulated chitinous hook; true penis anterior to pseudopenis, being a bent, chitinous tube. Anterior legs scarcely half as large as either of the others and each tibia with three ventral spines; tibial thumbs of second and third pairs of legs, each with a distal, stout spine. Length of female, 1.35 mm.; width of female, 0.52 mm. Length of male, 1.23 mm.; width of male 0.45 mm.

Type host and type locality: From a lemur, *Propithecus edwardsi,* taken at Ambodiasy, eastern Madagascar.

Type slide: Cat. No. 23762, U.S.N.M.

Specimens as follows: Two females and one male (on type slide) from female skin (Cat. No. 63352, U.S.N.M.) of *Propithecus edwardsi* taken at Ambodiasy, eastern Madagascar and two males from male skin (Cat. No. 63354, U.S.N.M.) of same host, taken at same place.

Proechinophthirus, gen. nov.

Forehead very short, almost obliterated; temporal regions with prominent, long, curved setae. Thorax longer than broad; sternum wanting. Abdomen long and clothed with both long setae and short spines. Genital armature of male with broad, unforked basal plate and slightly curved, freely projecting, unhooked parameres. First pair of legs greatly reduced, without tibial thumb, and in no way adapted for clasping.

Type of genus: Echinophthirius fluctus Ferris.

The type and only included species in this genus was described from specimens taken from an undetermined museum skin without data. In the United States National Museum there are several specimens taken from the fur seal (*Callorhinus alascanus*) at St. Paul Island, Alaska, by F. W. True and D. W. Prentiss, June 3, 1895.

In the nonsimilarity of the legs and the presence of long setae over practically all the body we have two good characters for differentiating this genus from *Echinophthirius* Giebel.

MATHEMATICS.—*A remarkable formula for prime numbers.*[1] PAUL R. HEYL, Bureau of Standards.

The expression $\frac{2^{n-1}-1}{n}$ is known to be integral for all odd prime values of n and non-integral for all even values of n. Numerical test shows that it is also non-integral for all odd composites up to $n=1000$ with the exception of 341 and 645. In other words, using this expression as a test for the prime or composite nature of a number, its indication that the number is composite is sound; but its indication that a number is prime is uncertain.

In order to handle the very large numbers to which such a use of this formula gives rise, we make use of the principle that if the product of several numbers $A\ B\ C \ldots\ldots$ be divisible by n with a certain remainder, the same remainder will be obtained if for any or all of the quantities $A, B, C \ldots\ldots$ we substitute $a, b, c \ldots\ldots$ their separate remainders when singly divided by n. For example: $\frac{17 \times 2}{3}$ gives remainder 1 as does also $\frac{2 \times 2}{3}$, 2 being the remainder of 17 divided by 3.

In general if

$$\begin{aligned} A &= a + nx \\ B &= b + ny \\ C &= C + nz \quad \text{etc.,} \end{aligned}$$

then $A\ B\ C \ldots\ldots = a\ b\ c \ldots\ldots +$ terms containing n, and the remainder of the whole expression after division by n will be the remainder resulting from the first term $a\ b\ c \ldots\ldots$

In the practical application of this formula one needs a calculating machine and a table of powers of 2. Such a table has been constructed by the author up to 2^{100}, and blue print copies of it will be furnished to any one to whom it would be useful.

As an example:

$$n = 483 = 3 \times 7 \times 23$$

Remainder of $\frac{2^{482} - 1}{483}$ should equal 0 if 483 is prime, which is equivalent to remainder $\frac{2^{482}}{483} = 1$

$$2^{482} = (2^{24})^{20} \times 2^2$$

[1] Received January 14, 1923. Presented at the Annual Meeting of the Philosophical Society.

Substituting for 2^{24} its remainder when divided by 483, namely 211, we obtain:

$$211^{20} \times 4 = (211^2)^{10} \times 4$$

Taking remainder of 211^2 $\quad 85^{10} \times 4 = (85^2)^5 \times 4$

$$463^5 \times 4 = 463^4 \times 463 \times 4$$

Remainder of $463^2 = 400$ and of $463 \times 4 = 403$
Hence we obtain $\quad 400^2 \times 403$

$$127 \times 403 = 51181$$

the remainder of which is 466, not unity; hence 483 is composite. Also, remainder of $\dfrac{2^{482} - 1}{483} = 465$. This remainder, resulting from the original formula, will in about 75 per cent of the cases examined (1000 in number) contain a factor of the original number, which may be found by the usual arithmetical process. For example:

$$\begin{array}{l}
465)483(1 \\
\quad\;\; \underline{465} \\
\quad\;\;\;\; 18)465(25 \\
\quad\quad\quad\;\;\; \underline{36} \\
\quad\quad\quad\;\;\; 105 \\
\quad\quad\quad\;\;\;\; \underline{90} \\
\quad\quad\quad\;\;\;\; 15)18(1 \\
\quad\quad\quad\quad\quad\; \underline{15} \\
\quad\quad\quad\quad\quad\;\;\; 3 = \text{H. C. F.}
\end{array}$$

The time required for such an operation is, for large numbers, very much less than that required for trying prime divisors up to $\sqrt{n}$. For example, a number of the order 10^8 might require the trial of 1228 primes, which, at the rate of one division per minute, would take 20 hours. By the method of powers of 2 the reduction can be made in one hour.

This method lends itself admirably to checking, as the original numerator can be expressed in several different ways, for example:

$$2^{482} = (2^{24})^{20} \times 2^2 = (2^{16})^{30} \times 2^2 = (2^{50})^9 \times 2^{32} \quad \text{etc.,}$$

each leading, on reduction, to a different series of numbers, but all ending in the same way.

BIOMETRICS.—*Contribution to quantitative parasitology.*[1] ALFRED J. LOTKA.

An analytic study of the quantitative relations between a population of host organisms and a parasite species preying upon such a population has been made by W. R. Thompson.[2] The time unit employed by this author is virtually a "generation"; thus, for example, he enquires how many generations must pass, after introduction of the parasite, to practically exterminate the host species. There is something unsatisfactory in this, inasmuch as the delimitations of a generation are, in the nature of things, ill-defined. So, for example, if we consider the progeny of a thousand human males born on January 1, 1900, the births of their sons will stretch over a continuous period from about 1920 to 1950, the births of their grandsons from 1940 to 2000, their great-grandsons from 1960 to 2050, and so on. In a mixed population the limits of a generation are still more indefinite.

For this and other reasons it seems desirable to approach from another angle the problem broached by W. R. Thompson. This may be done as follows:

Let N_1 denote the number of "healthy" hosts, i.e., individuals not attacked by the parasite, and let N_2 be the number of parasites in the adult (free-living) state. The number N_1 of healthy hosts will be augmented, per unit of time, by b_1N_1 births; it will be diminished, per unit of time, by two separate terms, namely first d_1N_1 deaths from other causes, and, second, by $a_1N_1N_2$ attacks by parasites. We shall here consider the case in which attack is always fatal, so that no recoveries occur; then we have

$$\frac{dN_1}{dt} = b_1N_1 - d_1N_1 - a_1N_1N_2 \qquad (1)^{3}$$

where the coefficients b_1, d_1, a_1 are, in general, functions of N_1 and N_2.

The parasite considered by W. R. Thompson is one that deposits a single egg in each host attacked. We may at once proceed to the more general case, that k eggs are deposited in each larva attacked, out of which h are actually hatched. In that case the number of

[1] Papers from the Department of Biometry and Vital Statistics, School of Hygiene and Public Health, Johns Hopkins University, No. 83. (Received Jan. 30, 1923).

[2] Comptes Rendus vol. 174 (1922) pp. 1201, 1433; vol. 175, p. 65.

[3] (1) might of course be written in the perfectly general form

$$\frac{dN_1}{dt} = \varphi\,(N_1,\ N_2)$$

But this would fail to bring out the fact that the first two terms must vanish with N_1 and the third with N_1 and also with N_2.

births per unit of time in the parasite species will be, evidently, $ha_1N_1N_2$. If the deaths among parasites are d_2N_2, we have

$$\frac{dN_2}{dt} = ha_1N_1\,N_2 - d_2\,N_2 \tag{2}$$

Simplifying our notation we will write (1) and (2) in the form

$$\frac{dX}{dt} = uX - vXY = X(u - vY) \tag{3}$$

$$\frac{dY}{dt} = -UY + VXY = Y\,(VX - U) \tag{4}$$

where the coefficients u, v, U, V, are in general functions of X and Y.

A state of equilibrium (which may or may not be stable) ensues when

$$X = \frac{U}{V} = p \tag{5}$$

$$Y = \frac{u}{v} = q \tag{6}$$

Introducing new variables

$$x = \frac{X-p}{\sqrt{pv}} = \frac{X-p}{\alpha} \tag{7}$$

$$y = \frac{Y-q}{\sqrt{qV}} = \frac{Y-q}{\beta} \tag{8}$$

we find

$$\frac{dx}{dt} = -\alpha\beta\left(y + \frac{\alpha}{p}\,xy\right) \tag{9}$$

$$\frac{dy}{dt} = \alpha\beta\left(x + \frac{\beta}{q}\,xy\right) \tag{10}$$

In these equations α and β are functions of x and y, since they contain v and V. We may write

$$\alpha = \alpha_0 + \alpha_1x + \alpha'y + \alpha_{11}x^2 + \alpha_1'xy + \alpha''y^2 + .\ . \tag{11}$$

$$\beta = \beta_0 + \beta_1x + \beta'y + \ldots \tag{12}$$

Substituting (11), (12), in (9), (10) we obtain

$$\frac{dx}{dt} = -\alpha_0\beta_0\left\{y + \left(\frac{\alpha_0}{p} + \frac{\alpha_1}{\alpha_0} + \frac{\beta_1}{\beta_0}\right)xy + \left(\frac{\alpha'}{\alpha_0} + \frac{\beta'}{\beta_0}\right)y^2 + \ldots\right\} \tag{13}$$

$$\frac{dy}{dt} = \alpha_0\beta_0\left\{x + \left(\frac{\alpha_1}{\alpha_0} + \frac{\beta_1}{\beta_0}\right)x^2 + \left(\frac{\beta_0}{q} + \frac{\alpha'}{\alpha_0} + \frac{\beta'}{\beta_0}\right)xy + \ldots\right\} \tag{14}$$

or, putting

$$T = \alpha_0\beta_0 t \tag{15}$$

and fusing constants in obvious notation

$$\frac{dx}{dT} = -y + \quad Bxy + Cy^2 + \quad Ex^2y + Fxy^2 + Gy^3 + \ldots = M \tag{16}$$

$$\frac{dy}{dT} = x + \quad A'x^2 + B'xy + \quad D'x^3 + E'x^2y + F'xy^2 + \ldots = N \tag{17}$$

Consider now the function

$$\varphi = x^2 + y^2 + 2(A'+B)\frac{x^3}{3} - 2(B'+C)\frac{y^3}{3} + 2[(A'+B)B + E + D']\frac{x^4}{4} + 2[(B'+C)B' - G - F')\frac{y^4}{4} \tag{18}$$

With the function thus defined let us form the expression

$$\frac{d\varphi}{dT} = \frac{\partial\varphi}{\partial x}\frac{dx}{dT} + \frac{\partial\varphi}{\partial y}\frac{dy}{dT} = M\frac{\partial\varphi}{\partial x} + N\frac{\partial\varphi}{\partial y} \tag{19}$$

It is thus found that

$$\frac{d\varphi}{dT} = 2(BC - A'B' + E' + F)\, x^2y^2 + S \tag{20}$$

$$= \left(\frac{\beta_1}{q} - \frac{\alpha'}{p}\right) x^2y^2 + S = Rx^2y^2 + S \tag{21}$$

where S contains only terms of 5th and higher degree. So long as x, y, do not exceed a certain value, the term of fourth degree is the one that determines the sign of $\frac{d\varphi}{dT}$. In that case evidently,

$$\frac{d\varphi}{dT} \gtreqless 0 \text{ according as } R \gtreqless 0, \text{ i.e., as } \frac{\beta_1}{q} \gtreqless \frac{\alpha'}{p} \tag{22}$$

Now consider the family of curves defined by

$$\varphi = \text{constant} = K \cdot \tag{23}$$

It is clear from (18) that in the immediate neighborhood of the origin these are concentric circles of radius $\sqrt{K}$. More generally, near the origin, they are closed curves enclosing the origin, and such that the curve $\varphi = K_2$ completely encloses (without contact) the curve $\varphi = K_1$, if $K_2 > K_1$

Consider the case

$$R > 0 \tag{24}$$

$$\frac{d\varphi}{dT} > 0 \tag{25}$$

At time $T = 0$ let

$$\begin{aligned} x &= x_0 \\ y &= y_0 \\ \varphi(x_0, y_0) &= K_0 \end{aligned} \tag{26}$$

Then at time $T + dT$

$$\begin{aligned} x &= x_1 \\ y &= y_1 \end{aligned} \tag{27}$$

$$\varphi(x_1, y_1) = \varphi(x_0, y_0) + \frac{d\varphi}{dT}\, dT \tag{28}$$

$$= K_1 \tag{29}$$

$$> K_0 \tag{30}$$

But the curve $\varphi = K_0$ is wholly enclosed within the curve $\varphi = K_1$. Therefore the point x, y always moves from any given curve $\varphi = K$ to a neighboring one $\varphi = K'$ lying wholly outside the former. Hence, having once left the area enclosed by $\varphi = K$, the point can never again enter it. It follows that when $R > 0$ the origin is a point of unstable equilibrium. Similarly it is readily shown that if $R < 0$ the origin is a point of stable equilibrium, and the point x, y continually approaches the origin. (See Fig. 1.)

This approach, however, is asymptotic, the origin is never quite reached within finite time. For, when, x y are very small, we have simply, by (16), (17)

$$\left.\begin{aligned} \frac{dx}{dT} &= -y \\ \frac{dy}{dT} &= x \\ xdx + ydy &= 0 \end{aligned}\right\} \tag{31}$$

$$x^2 + y^2 = r^2 = \text{constant} \tag{32}$$

$$\begin{aligned} x &= r \cos T \\ y &= r \sin T \end{aligned} \tag{33}$$

Thus in its final stages the process is nearly periodic, with a period $T_p = 2\pi$, or $t_p = 2\pi\alpha_0\beta_0$, the rise and fall of the parasite popula-

tion, as measured by y, lagging by one quarter-period behind that of the host population as measured by x.

More generally, if we write (16), (17) in the form

$$\frac{dx}{M} = \frac{dy}{N} \tag{34}$$

then the integral curves of (34), when x and y are plotted in rectangular coördinates, are spirals[4] closing in toward the origin and becoming

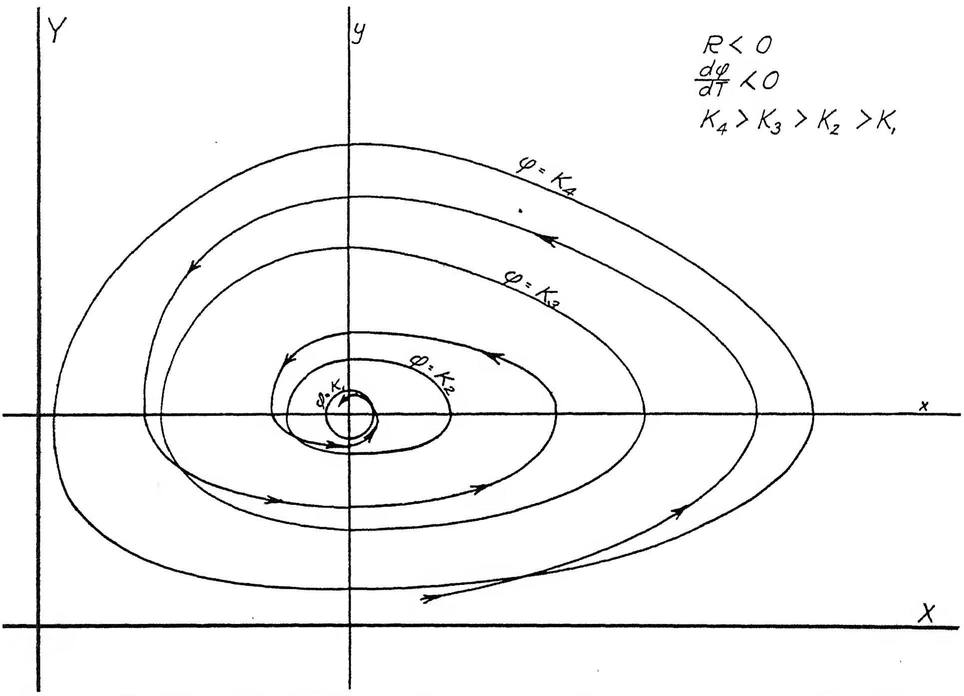

Fig. 1. Illustration of the argument: The curves $\varphi = K$ form a family, curves of lesser K being wholly enclosed by those of greater K. When $R < 0$ then $\frac{d\varphi}{d\tau} < 0$, and the integral curves are therefore traversed in inward direction (see arrows). The zones between the curves $\varphi = K$ thus form a trap, as it were, for the point x, y, permitting only one-way traffic, toward the origin. This latter is therefore a point of stable equilibrium.

more and more nearly circular as they do so; the process is no longer strictly periodic for larger amplitudes, though it remains oscillatory. It is interesting to compare this conclusion with Dr. L. O. Howard's

[4] For, according to (9), (10), $\frac{dy}{dx}$ and $\frac{y}{x}$ are always of opposite sign so long as $x > -\frac{p}{\alpha}, y > -\frac{q}{\beta}$.

observation: "With all very injurious Lepidopterous larvae we constantly see a great fluctuation in numbers, the parasite rapidly increasing immediately after the increase of the host species, overtaking it numerically, and reducing it to the bottom of another ascending period of development.[5]

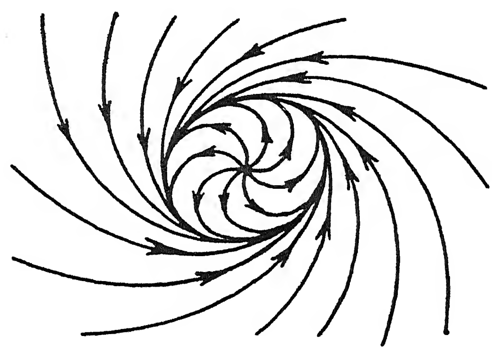

Fig. 2. Special case. Integral curves are spirals winding about the origin and about a limiting cycle, after the pattern of the *eye* of a cyclone.

In the limiting case that R = 0 we must establish, in place of the function φ, a similar function φ'

$$\varphi' = x^2 + y^2 + \varphi_3 + \varphi_4 + \varphi_5 + \varphi_2 + \ldots + \varphi_i \tag{35}$$

and the stability of the system at the origin of x, y then depends on the first ϕ_i of even degree for which the condition

$$M\frac{\partial\varphi'}{\partial x} + N\frac{\partial\varphi'}{\partial y} = 0 \tag{36}$$

cannot be satisfied.[6]

[5] L. O. Howard. A Study in Insect Parasitism. U. S. Department of Agriculture, Bureau of Entomology, Technical Series No. 5, 1897, p. 48.

[6] See Poincaré, Jl. de Mathématique 1885 ser. 4, vol. 1, p. 178; Picard, Traité d'Analyse vol. 3, p. 217.

A special case arises when the condition (36) can be satisfied indefinitely for all the polynomials φ_i, the function φ' being, in this case, an infinite series. The integral curves of (34) are then no longer spirals but a family of closed curves enveloping each other and enclosing the origin. The oscillations of the system are in this case undamped and continue indefinitely.[7]

There may also be another type of periodic oscillations, in which the integral curves of (34) are spirals winding, not into the origin, but asymptotically about a limiting cycle (Fig. 2). The process, in such case, is not at first exactly periodic, but becomes more and more nearly so as time goes on.

This case bears a certain analogy to conditions that sometimes arise in cyclones and water spouts.[8] In point of fact Fig. 2 is reproduced from Bjernke's Dynamic Meteorology[9] and illustrates the so-called *eye* of a cyclone. I presume that the *sleeve* of a waterspout is a concrete and material visualisation of the limiting cycle in a vortex of this type.

[7] The purely periodic type of process was considered by the writer on a former occasion (Proc. Nat'l. Acad. Vol. 6, 1920 p. 410; Jl. Am. Chem. Soc. Vol. 42, 1920 p. 1595.) It may be remarked that the expression then given for the period of oscillation holds true only near the origin. The statement that this period is independent of the amplitude requires correction.

[8] Monthly Weather Review 1915 Vol. 43, p. 550.

[9] Carnegie Institution No. 88 Part 2, p. 52.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY

351ST MEETING

The 351st meeting of the Society was held October 5, 1922, at the New National Museum, with President GAHAN in the chair and 36 persons present. Mr. L. J. BOTTIMER was elected to membership.

E. G. REINHART: *The life history and habits of the solitary wasp,* Philanthus gibbosus. This paper was discussed by Messrs. BRIDWELL, HOWARD, ROHWER, and ALDRICH.

Dr. BAKER opened a discussion on the use of the common names "grasshopper" and "locust," in which Messrs. CAUDELL, WALTON, HOWARD, HYSLOP, ALDRICH, BALL, HEINRICH, ROHWER, BARBER, GAHAN, and BRIDWELL took part. The consensus of opinion was that the name "grasshopper" rather than "locust" should be used.

WM. SCHAUS exhibited 5 moths and 1 larva of *Zelotypia stacyi* Scott; *Phassus triangularis* Hy. Edwards, a female with a specimen of the larva; *Phassus giganteus* Hen. Schaeff., a male and female. The larvae and pupae of these insects move up and down through long galleries. Larvae of *Phassus triangularis* live within the stems of a species of the ash family in Mexico, and in many cases trees are honey-combed by their galleries. Larvae of *Zelotypia stacyi* live in a similar manner in eucalyptus branches.

352D MEETING

The 352d meeting of the Society was held November 2, 1922, at the New National Museum, with Dr. L. O. HOWARD in the chair and 47 persons present.

In the first address of the evening Prof. C. P. LOUNSBURY, of the Union of South Africa, gave an account of entomological work in South Africa.

The Imperial Bureau of Entomology with headquarters at London is maintained by the cooperation of South Africa, Canada, New Zealand and other British dependencies and is a clearing house for determinations and entomological information for the British Colonies. Entomologists have been appointed to various colonies north of South Africa but these have no connection with the Union of South Africa. One function of the Entomological office of the Union is to enforce the various quarantine acts and for this purpose an entomologist is stationed at each of the principal ports. These men play the part of guardians against the importations of dangerous insects or plant diseases. Another duty of the division is the general supervision of the insecticides and fungicides, a work similar to that done by the U. S. Department of Agriculture. The Division looks to Washington for guidance and assistance and often models its rules, regulations, and policies after the U. S. Federal Bureau.

The paper was discussed by Messrs. ALDRICH, SCHWARZ, and HOWARD.

Prof. ULRICH DAHLGREN, professor of biology at Princeton University, spoke on the luminosity of insects. He said that luciferene works similar to the blood. He is looking especially for the species of fire flies which have green lights along their sides and red lights in the head. He is also studying the reversing of the light process. The light produced is over $99\frac{1}{2}$ per cent pure and without heat.

J. E. Graf exhibited specimens of the Mexican Bean Beetle. He stated that these parasites would mate and produce under all conditions. A binocular is necessary to detect the eggs as they cannot be detected with a hand lens.

John C. Hamlin, who is employed by the Commonwealth of Australia to investigate the insects which will destroy the cactus, stated that this plant is a great pest in Australia. Experiments for utilizing cacti in making paper pulp showed that it took too many cacti to produce a small quantity of pulp. Therefore, the experiments failed commercially. The pulp was unsatisfactory because it had to have wood fibre mixed with it.

Mr. Hamlin stated that he was engaged in rearing insects which are natural enemies of the cacti to be used as a means of controlling the cacti. He also stated that one generation was reared in this country and that two generations are reared in Australia before the insects are released to carry on the part for which they were taken there. This precaution is undertaken in order that no injurious parasites will be introduced that might become pests on useful crops.

Dr. Aldrich reported that he had lately identified *Muscina pascuorum* Meigen, a European species from New England. Mr. C. W. Johnson of the Boston Society of Natural History writes that the species has been found in several New England localities within a few days of each other, indicating that it has spread rapidly.

Dr. Howard recalled the fact that he had presented at an earlier meeting of the Society a somewhat lengthy review of the biographical accounts of Fabre published after his death in 1915 by Bouvier and Ferton. He stated that recently he had published in the Magazine *Natural History* (vol. xxii, No. 4, July–August, 1922), an article entitled *A pilgrimage to the home of Fabre,* in which he described his visit to "Harmas" in the summer of 1920, and, while summarizing Ferton's criticisms of Fabre, tried nevertheless to give a high appreciation of the value of Fabre's work and quoted the estimate given by Wheeler in his introduction to the book by Raus entitled *Wasp studies afield,* in which Fabre is reckoned as one of the three greatest entomologists, the others being Reaumur and Latreille. The speaker's reason for making this statement at the present time is that in the current number of the *American Review of Reviews* a page is devoted to the article in *Natural History,* under the title *Fabre's scientific shortcomings,* and the review consists almost entirely in bringing out the Ferton criticisms, ignoring the final estimate of the enormous value of Fabre's work. In this way the review conveys an impression which is unfair to Fabre, unfair to the speaker, and unfair to the publishers of the many editions of Fabre's books.

SPECIAL MEETING

A special meeting was held on November 8, 1922, on the occasion of an illustrated address on *The respiration of insects* by Dr. August Krogh of Denmark, with Dr. L. O. Howard in the chair and 60 persons present. Dr. Howard stated that this was the first special meeting of the Society since the meeting of February 28, 1894, at which Prof. E. B. Poulton, of Oxford University, addressed the Society.

Dr. August Krogh said that the suggestion to study the respiration in insects with a tracheal system came to him after listening to a paper on the anatomy of a Carabid larva read in Copenhagen by Dr. A. G. Böving more than ten years ago. He learned about the forceful muscle complex

insects and their ability for considerable contraction of the body, and first thought that Dr. Böving was right in supposing that the expiration of the air from the tracheae was brought about by a complete compression of this entire system, following a simultaneous contraction of all the body muscles, and that the inhalation followed when the elastic tracheal walls again expanded as a result of relaxation of the muscles. Later he reconsidered this idea and could hardly believe that the pressure of the muscles was strong enough to affect the total compression of the whole system with all its fine tracheal branches. Therefore he began to consider another way in which the respiration could be performed. The only other possible alternative would be respiration by a diffusion of the air through the fine branches of the tracheal tubes. Before he started the research work he thought out as a working base the following formula for respiration through diffusion: Respiration is equal to a constant representing the amount of oxygen which in a chosen unit of time, for instance one second, multiplied by a fraction, the numerator of which is the difference in pressure of the oxygen in the atmosphere and at the bottom of the air tubes multiplied by the total transverse area of the tracheal tubes, the denominator of which is expressed by the length of the air tubes of the whole tracheal system. In insect larvae, for instance in a *Cossus* larva, the amount of oxygen absorbed in a certain unit of time can be measured by respiration experiments, and to determine the average lengths and the total of width of the tracheal system the author had filled the tracheal system of a *Cossus* larva with a solution of stained fat and then separated the complete tracheal system by dissolving all the tissues with Pepsin-muriatic acid. The result of this preparation of the tracheal system was shown on the screen. By measuring length and total width of the tracheal system of different larvae and knowing the amount of oxygen diffused, he found that a difference of about 2 per cent in the oxygen outside and inside was all that was necessary for the sufficient supply of oxygen through a process of diffusion. This result was substantiated by direct measurements of the diffusion of the air in the tracheae of *Cossus*. By experiments he could also prove that special respiration movements were not present and also that even a forceful contraction of the entire musculature of the body wall would only result in a slight and unimportant expiration of air. The results acquired were generalized to apply to most larvae and probably all pupae, to almost all very small insects, and to all Arachnids and Myriopods.

The most difficult problem is to supply air in the long slender organs, like the legs of many Arachnids. It has been shown by Dr. H. F. Hansen, in Copenhagen, that there are extra spiracles on the tibiae of long legged *Opiliones*. In the larger adult insects the length of the tracheal tubes is often considerable, and respiration through diffusion alone would not suffice. In these forms an additional mechanical ventilation takes the place of the larger main tracheal tubes and the air sacks.

The ventilation-tubes differ from the diffusion tubes in being easily compressed; often their cross section is narrowly elliptical. Similar ventilation-tracheae and a mechanical respiration are present in the water beetle larvae with the single pair of spiracles at the end of the abdomen. In connection with investigations of the large *Dytiscus* larvae, Dr. Krogh had measured the normal amount of exhaled air, the maximal amount of exhaled air by voluntary respiration, the greatest possible amount of exhaled air, or the vital capacity, and the total area of the tracheal system at the time when the larva was in its normal inhalation or resting position. In a larva weighing 1.7 grams he found that the total area of the system amounted to 107 mm.[3]

Out of these 86 mm.[3] were present in ventilation tracheae and could be expelled by a difference of 1 atmosphere, while the diffusion tracheae were very slightly affected by the same pressure. The normal renewal of the air in the ventilation tracheae amounted to 55 mm.[3], and by deep respiration 68. Hence the ventilation of the tracheae built for that purpose was very complete, and as the speaker had pointed out, was necessary for an effective respiration.

In conclusion Dr. Krogh pointed out the biological connection between the small size of insects and the tracheal form of respiration. By an increase in the size of the animal the difficulties of supplying the air through diffusion from tracheae increase considerably without an effective system of blood circulation. Hence the size of insects is limited by their peculiar respiratory system which is only adapted to animals of small size.

The above lecture was well illustrated by lantern slides and summarizes the material included in the following four papers by Dr. Krogh:

1. "On the composition of the air in the tracheal system of some insects." Skand. Arch. Physiol., vol. 29, 1913.

2. "Uber gas diffusion in den Tracheen." Pflüger's archiv. für Physiologie, vol. 179 1920, pp. 95–112.

3. "Die Kombination von mechanischer Ventilation mit gasdiffusion nach Versuchen an Dytiscuslarven." Pflüger's archiv. für Physiologie, vol. 179, 1920, pp. 113–120.

4. "Injection preparation of the tracheal system of insects." Videnskabelige Meddelelser Dansk naturhistorisk Forening, vol. 68, 1917.

353d MEETING

The 353d meeting of the Society was held December 7, 1922, at the New National Museum, with President Gahan in the chair and 36 persons present.

The following officers were elected for 1923: President, Dr. L. O. Howard; First Vice-President, Dr. A. G. Böving; Second Vice-President, R. A. Cushman; Editor, Dr. A. C. Baker; Recording Secretary, Mr. C. T. Greene; Corresponding Secretary-Treasurer, Mr. S. A. Rohwer. Executive Committee, A. N. Caudell, Dr. A. L. Quaintance, Dr. J. M. Aldrich. Nominated to represent the Society as Vice-President of the Washington Academy of Science, Mr. S. A. Rohwer.

Program:

Dr. A. G. Böving: *The biology of the Blister-beetles.* Much knowledge is still lacking of the life history and structural details of many of the Blister-beetles, this being especially true about our American ones. Out of 31 North American genera we have complete biological records of only one, namely *Epicauta* described by Riley, and partial records of two, *Hornia* and *Macrobasis;* but the life histories are unknown of the remaining 29 genera, among which are forms as *Megetra* and *Eupompha* whose imagines show the most extraordinary features.

The different stages of the metamorphosis of the Blister-beetles were given as the egg-stages, the six larval stages, the pupal and imaginal stages. The shape and size of the eggs, their number, the way in which they are deposited was explained in detail.

The diet of the larvae was the next topic and a review was given of the results obtained by several authors who have studied this question; particular attention was paid to Dr. A. Cros' papers. The first instars vary greatly in shape according to the nature of their food and especially according to the ways in which they reach their food supply. Thus the first instars of the *Zonabrini*, *Epicautini* and *Lyttini* feed either on young Mantes, gathered

together in the nests of the Tachys, or an egg-pods of grasshoppers, or on the honey, eggs and larvae of solitary bees; they search directly for their food, and keep to the ground and avoid direct sunlight, and in all of these genera the first instars look like small *Staphylinid* larvae. In the tribe *Meloini* and the entire subfamily *Nemognathinae* the first instars are mellivorous and reach the nest of their host-bee by grasping and clinging to its hair, when they come in contact with it; they are active in broad daylight and are very specialized in shape. The peculiar adaptation shown in the excavation of nasals and the form and articulation of the mandibles were mentioned, as well as the remarkable breathing structures on the eighth abdominal segment of all the *Nemognathinae*. The second to sixth instars of the different groups were characterized; a special emphasis was laid on the different behavior of the errant and the sedentary fourth instars, and the different ways were mentioned in which the cast skins of the fourth, fifth and sixth instars were manipulated and made use of by the insects.

The terms "caraboid," "scaraboid" and "scolytoid" larvae were explained and their history given; the terms, however, were not considered applicable to the stages of the Blister-beetles in general.

The theory of Fabre and other authors concerning a hypermetamorphic development was presented and the objections to this theory and term by Riley and many modern entomologists were reviewed. In this connection an account was given of many cases of abnormal individual evolution in Blister-beetles. Several adaptations occurring in the pupae were mentioned. As to the exceedingly interesting biology of the adults the speaker referred to the works of Fabre, Beauregard and Cros, in which this subject was treated with great clearness and many details were described.

CHAS. T. GREENE, *Recording Secretary*.

CHEMICAL SOCIETY

337TH MEETING

The 337th meeting was held at the Cosmos Club Thursday evening, January 11, 1923. The retiring President, Dr. R. C. WELLS, spoke on *Chemistry of the sea*, illustrating his talk with lantern slides.

DOCTOR WELLS referred to recent progress in methods of sounding which yield data for calculating the volume and physical constants of the ocean. Its chemical composition has been widely studied and some thirty-two elements have been detected in sea-water. The salinity is maintained at definite values in certain regions owing to the interplay of such forces as currents, evaporation, density, temperature, etc. To illustrate some of these relationships data on the water of Chesapeake Bay were presented in some detail. This investigation is being carried on jointly by the Geological Survey and the Bureau of Fisheries. The salinity of the Bay varies from about 6 in the latitude of Baltimore to 27 at the Capes, also generally increasing with depth.

The speaker discussed among other things the origin of oceanic salts, the "age of the ocean," and the salts that are successively deposited on evaporating sea-water.

The gases in sea-water are of particular interest in connection with living things in the sea. Some of these gases show diurnal variation in concentration, following the daily photochemical reactions in plants near the surface and along shores. A variation in pH value follows one in carbon dioxide content, etc. The carbon dioxide content is also fundamental in determining

the solubility of calcium carbonate, which is an important constituent of rocks. Organisms vary specifically in the secretion and removal of certain elements from sea-water, temperature also playing a part. The speaker briefly sketched the rôle of certain organisms in removing certain elements, and alluded to the great variety of specific and selective reactions accomplished by the different organisms.

SCIENTIFIC NOTES AND NEWS

John Oliver La Gorce, associate editor of the National Geographic Magazine and trustee of the National Geographic Society, has been elected a vice-president of the Society.

Mr. La Gorce has been associated with the National Geographic Society since 1905.

N. H. Darton has returned to his office in the U. S. Geological Survey after an absence of nearly two years completing the field work on the geologic map of Arizona. The University of Arizona recently conferred on Mr. Darton the honorary degree of Doctor of Science in "recognition of his investigations on the geology of the Southwest."

Two additional societies have been elected to affiliation with the Academy. They are the Washington Section of the American Society of Mechanical Engineers, and the Helminthological Society of Washington.

The President recently signed a proclamation making a National Monument of three groups of towers in southwestern Colorado and southeastern Utah. This reservation was originally suggested by Dr. J. Walter Fewkes, Chief of the Bureau of American Ethnology, and the preliminary work has been done by the Bureau of Ethnology in coöperation with the National Park Service of the Department of the Interior. The monument is called The Hovenweep National Monument, the name being derived from the Ute word meaning "the deserted valley" and having been applied to a neighboring canyon many years ago.

The report of the Treasurer of Yale University includes the statement that a gift of securities having an appraised value of $25,475 has been received from Mrs. Estelle Iddings Cleveland, being the entire estate of her brother, the late Professor Joseph Paxson Iddings, formerly of Washington, for the establishment of the "Iddings Fund" for the promotion of research in petrology.

The Department of Geology, U. S. National Museum, has received as a gift from Dr. Frank Springer the paleontological collections of the late Orestes H. St. John. The collection contains a large and extremely valuable series of Selachian fishes including many type specimens, the most notable of these being a specimen from the Coal Measures of Kansas, containing the complete dentition of a large shark of paleozoic time.

The Petrologists' Club met on Tuesday, March 20. The subject for the evening was *Pegmatites*, discussed by Messrs. F. L. Hess, W. T. Schaller, and E. V. Shannon. Various authors have ascribed different connotations to the term pegmatite, but in general it refers to texture rather than composi-

tion. The mineral associations were dealt with in detail, especially cryolite, monazite, and their connection with pegmatite.

The Grass Herbarium, U. S. National Museum, has recently received several important collections from South American countries, including Peru, Argentina, and Brazil.

Mr. EDMUND F. DICKINS, hydrographic and geodetic engineer in the U. S. Coast and Geodetic Survey since 1869, died at San Francisco, California, March 2, 1923, in the seventy-seventh year of his age, after a service of 51 years. He had been retired from active duty since 1920. He was director of coast surveys in the Philippine Islands from 1908 to 1911, and had held many other important assignments.

At the annual meeting of the Eye-Sight Conservation Council held in New York City in February, Dr. MORTON G. LLOYD of the Bureau of Standards was elected a director.

Senator HENRY CABOT LODGE has been reappointed as a Regent of the Smithsonian Institution for six years, beginning March 4, 1923.

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BOTANY.—*The identification of Raddi's Grasses.*[1] AGNES CHASE, U. S. Department of Agriculture.

One of the earliest works treating of the grasses of America is the Agrostografia Brasiliensis sive Enumeratio Plantarum ad familias naturales Graminum et ciperoidarum spectantium, quas in Brasilia collegit et descripsit [by] Josephus Raddius, published at Lucca, Italy, in 1823. This little book of 58 pages and one plate is exceedingly rare. In it are described 26 species of Cyperaceae (sedges) and 65 species of Poaceae (grasses). Of the latter five genera and 35 species are proposed as new. A few of these had been described earlier by Bertoloni in a paper in Opusculi scientifici . . di Bologna in 1819. Raddi's work and the specimens on which it is based are of great nomenclatorial importance to agrostology.

Giuseppe Raddi was born in Florence, Italy, February 9, 1770. In 1817, when the Austrian emperor seized the opportunity to send a scientific expedition to Brazil with the escort of the Archduchess Leopoldine on her voyage to Brazil to marry the heir apparent to the Brazilian throne, the Grand Duke of Tuscany sent Raddi to join the expedition. Raddi spent two years in Brazil in the vicinity of Rio de Janeiro. Presumably his work was chiefly that of securing seeds and living plants for the botanic gardens of Tuscany. He published three books based on his work in Brazil, Synopsis Filicum brasiliensium, 1819 (19 pages and 2 plates); Agrostografia brasiliensis, 1823; and Plantarum brasiliensium nova genera et species novae vel minus cognitae. Pars. I. Filices, 1825 (101 pages and 84 plates). Part I is the only one of the projected work ever published.

Raddi was later sent to Egypt and died at Rhodes on his return in 1829.

[1] Received March 9, 1923.

A set of Raddi's Brazilian grasses appears to have been given to the Museum at Florence but his own set is preserved in the University in Pisa.

In May, 1922, I visited the Museo e Laboratorio di Botanica, Florence, and the Instituto ed Orto Botanico della R. Universita in Pisa, for the purpose of studying these grasses. I took photographs of all Raddi's own species which I found in Pisa. Six I was not able to find. In the Pisa herbarium (and in Florence also) the visitor does not search the herbarium himself, he asks for the genera wanted and the packages are brought by an attendant. The Raddi grasses are distributed in the herbarium and it is possible that the missing specimens were distributed in genera I failed to guess.

The Raddi grasses in Pisa are unusually ample and well-prepared. They are mounted on the third page of a folder of rather heavy paper. The name is written on the outside of the folder (which could not be made to show in the photograph), and in most of the specimens there is a ticket bearing the name, usually in Raddi's hand, on the page with the specimen. There are no data on the tickets or on the folder, except that on the tickets that are not in Raddi's hand is written "Brasile."

In the Florence Herbarium I found several specimens of Paspalum with data on the labels. Among some undetermined grasses that Dr. Pampanini asked me to name were sixteen specimens without names or data other than "In Brasilia legit Cl. Raddi." Later I found a few Raddi specimens in the Delessert Herbarium and in the herbarium of the British Museum.

The following list is based on the Pisa specimens, those in the other herbaria are referred to only when they add some information, or when they differ from the Pisa specimens.

The species (beginning with the sedges) are numbered consecutively throughout the book. These numbers are used in the following list. Except in a few cases, only Raddi's own species are given.

ANNOTATED LIST OF RADDI'S SPECIES

RETTBERGIA, a new genus including one species

27. RETTBERGIA BAMBUSIOIDES. *pl. 1. f. 1.* "Circa verticem Montis Corcovado." The specimen is a single leafy branch with a small rather dense panicle. This is *Chusquea bambusioides* (Raddi) Hack. Hackel[2] refers *C. gaudichaudii* Kunth to this species. Kunth's plate

[2] Denkschr. Akad. Wiss. Math. Naturw. (Wien) **79**: 81. 1908.

and description agree well with the photograph and notes taken of Raddi's specimen.

29. OLYRA PUBESCENS. "In montosis ubique in Provincia Rio Janeiro." There are two specimens of this, each consisting of a leafy branch with a panicle. The sheaths and blades are puberulent; otherwise the specimens are like *O. latifolia* L. Doell reduces it to a variety of that species, *O. latifolia* var. *pubescens* (Raddi) Doell. It is scarcely worthy of varietal rank. A specimen of typical *O. latifolia* L. is labeled "*Olyra pubescens* var." in Raddi's script. This is evidently the form referred to as having glabrous blades and sheaths. Nees[3] cites this as "*Olyra pubescens* var. *glabra* Raddi . . . . " under *Olyra scabra* Nees as a doubtful synonym.

In the Delessert Herbarium a specimen labeled "*Olyra pubescens* Raddi. Bresil: Raddi," but not in Raddi's script, is the same as *O. ciliatifolia* Raddi (no. 31).

30. OLYRA GLABERRIMA. "In Monte . . . . Corcovado." The specimen consists of the summit of a culm with three leaves and an immature panicle. The blades are very large, the largest being 26.5 cm. long and 5.6 cm. wide, short-petioled and with the base very unsymmetrical. The immature fertile lemma is densely bearded at the base and slightly at the summit with short thick hairs. *Olyra semiovata* Trin.,[4] "Brasil. (Langsdorff)," belongs to this species. Trinius's description applies well to Raddi's specimen, and a fragment from the Trinius Herbarium deposited in the United States National Herbarium shows an immature pistillate spikelet that agrees perfectly with that observed in the Raddi specimen. Raddi's description, "Corolla laevigata, straminea, coriaceo-indurata" is misleading. The lemma and palea are yellow (being very immature, as is the immature one from Trinius's specimen), but the dense pubescence at the base is to be seen by lifting up the sterile lemma. This characteristic fruit is well shown in Trinius's drawing of *O. semiovata*.[5] This species is well represented by Jardim Botanico do Rio de Janeiro no. 402 (without data other than Brazil) and *Ule* 979, "Pr. St. Catharina, Brazil."

31. OLYRA CILIATIFOLIA. "In saltibus montosis, et sepibus prope Rio-Janeiro, nec non in Montibus estrell." The specimen consists of two culms with immature panicles. The fruit shows the loose pubescence characteristic of the species as represented by *Hitchcock* 10133,

[3] Agrost. Bras. 307. 1829.
[4] Gram. Pan. 249. 1826.
[5] Trin. Gram. Icon. 3: 347. 1836.

Trinidad; *Lindman* A 2597, and *Glaziou* 14397, Brazil; *Hassler* 12444, 13021, and *Rojas* 3071, Paraguay; and *Ekman* 675, Argentina. The blades of the Raddi specimen are shorter in proportion to their width than common, as in *Hassler* 13021. In Grasses of the West Indies[6] the key is misleading in that the fruit of *Olyra ciliatifolia* is said to be "clothed with thick silky hairs at base and summit." The fruit is loosely pubescent throughout.

32. Olyra floribunda. "Ad radicem Montis Corcovado." The specimen consists of a tuft of five flowering culms and two sterile ones. Raddi cites "*Raddia brasiliensis*. Bert. Opusc. Scientif. di Bologna 1819. T. III p. 40." Bertoloni's detailed description agrees in every way with Raddi's specimen and was undoubtedly drawn up from a duplicate. (There seems to have been abundant material of this collection; there were two full sheets of it among the unidentified grasses in the herbarium at Florence, as well as a specimen in the Delessert Herbarium.) The distinguishing generic characters given are the distinct staminate and pistillate inflorescences. Bertoloni states that the generic name is given as a just tribute to Raddi and that the specific name commemorates his courageous voyage to Brazil. But Raddi declines the honor conferred on him and renames the species *Olyra floribunda*. He describes the distinct staminate and pistillate inflorescences but states that the style and stigmas are as in the three preceding species, and that they agree with the generic characters assigned by Swartz to *Olyra*. We recognize *Raddia* as a distinct genus, and this species as *R. brasiliensis* Bertol. The valid name under *Olyra* is *O. brasiliensis* (Bertol.) Spreng. I have seen no other collection which agrees exactly with the Raddi specimens. *Glaziou* 4336 and 12265, Brazil, probably belong to this species, but the blades are more than twice as large and the pistillate spikelets are larger and have a longer acuminate tip, but the spikelets are clothed, as in the Raddi specimens, with a dense short retrorse pubescence, with a few long stiff hairs intermixed.

33. Pharus brasiliensis. "Prope Rio-Janeiro." The specimen is a complete plant with a very immature panicle. The name on the folio is not "brasiliensis" but one that was not published. The plant agrees with Raddi's description, and as but one species of *Pharus* is given there can be no doubt that this is the type of *P. brasiliensis*. It agrees with rather narrow-leaved specimens of *Pharus glaber* H. B. K., such as *Blanchet* 1018, *Mosén* 1778, and *Dusén* 91, from

[6] Hitchcock & Chase, Contr. U. S. Nat. Herb. 18: 357. 1917.

Brazil. The last, from Rio Janeiro, has a very immature panicle and is an excellent match for Raddi's specimen.

34. SPARTINA BRASILIENSIS. "In inundatis prope Rio-Janeiro." There are two sheets of this, consisting of the upper part of a thick culm with inflorescence exceeded by the blades. The specimen is well represented by Doell's plate[7] except that the Raddi spikelets have a few hairs, as in *Glaziou* 22412, Brazil.

36. PASPALUS OBTUSIFOLIUS. "In herbosis et humidiusculis locis prope Rio-Janeiro." The specimen consists of four plants of one flowering culm each, the two racemes not conjugate. No stolons are present but the base of one suggests a stoloniferous habit. This species belongs to the genus *Axonopus*, which differs from *Paspalum* in the reversed position of the spikelets,[8] **Axonopus obtusifolius** (Raddi) Chase. Doell[9] refers this species to *Paspalum furcatum* Flügge (*Axonopus furcatus* (Flügge) Hitchc.), but it is very different from that species, especially in the inflorescence. In that the racemes are conjugate and the spikelets glabrous while in *Axonopus obtusifolius* one raceme is from 0.5 to 2 cm. below the other, and the spikelets are silky-villous at the base and with a narrow stripe of silky pubescence on the marginal internerves. *Ule* 975, from Brazil, agrees perfectly with Raddi's specimen and shows, besides, a leafy stolon.

39. PASPALUS ACUMINATUS. No locality is cited. The specimen consists of two leafy culms lacking the base, each with three racemes. This belongs to section *Ceresia* of *Paspalum* with broadly winged rachis, together with *P. dissectum* L., *P. serratum* Hitchc. & Chase, and *P. repens* Berg. It is the species given as *P. acuminatum* Raddi in Hitchcock's Mexican Grasses[10] and is well represented by *Brother Arsène* 3132, Mexico, and *Hassler* 10784, 11930 and 12471 from Paraguay.

40. PASPALUS LONGIFLORUS P. Beauv. Fl. de Ow. II 46. t. 85?—an Sp. nova. No locality is given. While Raddi does not here name a new species, "*Paspalum longiflorum* Raddi" has been given in synonymy by Doell and others. The specimen in the Pisa Herbarium consists of two culms of *Paspalum vaginatum* Swartz, both exceptional in the number of racemes, one having three, the other five. The specimen in the Florence Herbarium is *P. distichum* L.

41. PASPALUS FISSIFOLIUS. "Cum *Paspalo obtusifolio*." (See above.) There are five plants on the sheet, one of two flowering culms

[7] Fl. Mart. Bras. 2³: pl. 23. f. 2. 1878.

[8] See Chase, Proc. Biol. Soc. Washington **24**: 129. 1911.

[9] Fl. Mart. Bras. 2²: 103. 1877.

[10] Contr. U. S. Nat. Herb. **17**: 230. 1913.

joined by a long stolon, three single flowering plants of the same, and a sterile tuft that is probably *Stenotaphrum secundatum* (Walt.) Kuntze. The flowering plants agree with the description. The apex of several of the blades is split. This splitting of the blades is not uncommon in *Axonopus*, the genus to which this species belongs. This species, **Axonopus fissifolius** (Raddi) Chase, is allied to *A. compressus* (Swartz) Beauv. It is much smaller than that, with narrower blades, 3 to 4 racemes, and smaller spikelets with longer less delicate pubescence. The Pisa specimens and those seen in Florence and Delessert are about 12 cm. tall, or less; the one in the British Museum has a culm 18 cm. tall. I have seen no other collection of this species.

42. Paspalus curvistachyus. "In sylvestribus non procul ab urbe Rio Janeiro." There are two sheets of this, one with a ticket with the name in Raddi's script and two plants, the other with three plants. Both sheets contain two species, one, the left-hand plant on the first sheet and the left and middle plants on the second sheet, is the same as *Paspalum nutans* Lam., the type of which was examined in the Paris Herbarium. The description was evidently drawn up from both species, but two characters given, "glumis calycinis corolla brevioribus" (glume and sterile lemma shorter than the fruit), and "nodes rooting" apply to the specimens of *P. nutans* and not to the right-hand plant on each sheet. The left-hand plant of the second sheet, being the best specimen, is selected as the type. This specimen has four racemes in the terminal inflorescence and one on each of two branches. It is well matched by *Hitchcock* 10301, Trinidad, with three racemes in the terminal inflorescence.

The right-hand specimens on each sheet are over-mature single plants of *Paspalum arenarium* Schrad.

In the Delessert Herbarium a specimen of this collection "E Brasilia, Raddi" bears a name that was not published. It agrees with the type. The specimen in the Florence Herbarium is *P. arenarium*. Doell[11] refers *Paspalum curvistachyum* Raddi to *Panicum decumbens* Roem. & Schult. (*Paspalum decumbens Swartz*). That is an allied species with smaller spikelets in which the first glume is developed.

43. Paspalus corcovadensis. "Monte Corcovado." The specimen consists of one entire plant and a second lacking the base. These agree perfectly with the description. They are well matched by *Gardner* 138, and *Mosén* 3512, from Brazil. Trinius[12] figures a different species with shorter broader blades and more numerous and

[11] Mart. Fl. Bras. 2[2]: 183. 1877.
[12] Gram. Icon. 2: 153. 1829.

denser racemes under the name *P. corcovadense* Raddi. Doell[13] reduces *P. corcovadense* Raddi to a variety of *P. laxum* Lam., changing the name to P. *laxum β Raddianum* Doell. The type specimen of *Paspalum laxum* Lam., examined in the Paris Herbarium, however, proves to be a very different species, closely allied to *P. glabrum* Poir.

I should take *Paspalum corcovadense* for the valid name of this species, through the description of *Paspalum lanceolatum* Mikan[14] is evidently drawn up in part from a specimen of this species. Dr. A. S. Hitchcock, who examined the Trinius Herbarium in 1907, found the specimen collected by Mikan in Brazil and bearing the name "*Paspalum lanceolatum*" to consist of two species, one of which is the same as Raddi's species, but the other a species not closely related. Trinius's description of the vegetative part applies much better to the latter, as does also the number of the racemes ("12–15"), but the description of the spikelets applies to *P. corcovadense* and not to the acute spikelets of the plant otherwise described. Neither of the specimens belongs to the species figured in the Icones as *P. corcovadense* (which Doell[15] names *P. densiflorum* Doell). Trinius later[16] reduces *P. lanceolatum* Mikan (described by himself in 1821) to *P. corcovadense* Raddi (1823), and cites his own plate also. The description is adjusted to cover the three species. For the type of *P. lanceolatum* Mikan; Trin., I select the plant with the acute spikelets, leaving *P. corcovadense* Raddi the valid name for the species represented by *Gardner* 138 and *Mosén* 3512, from Brazil.

44. PASPALUS INAEQUIVALVIS. "In sylvestribus prope Mata-Cavallos, non procul ab urbe Rio de Janeiro." The specimen consists of two plants, one lacking the base. This belongs to the species figured under this name by Kunth,[17] and is well represented by *Hassler* 12401 and *Rojas* 96 from Paraguay, and *Ekman* 569, from Misiones, Argentina.

The specimen in the Delessert Herbarium bears a name that was not published.

45. PASPALUS COMPRESSICAULIS. "In graminosis prope Rio-Inhumirim." The specimen consists of a complete plant of the common *Paspalum paniculatum* L.

48. *Piptatherum annulatum.* "An var Piptatherii punctati P. B.? . . . ad Fossas udas prope Rio-Janeiro." On the specimen is

[13] Mart. Fl. Bras. 2²: 85. 1877.

[14] Trin. in Spreng. Neu. Entd. 2: 48. 1821.

[15] Mart. Fl. Bras. 2²: 51. 1877.

[16] Mem. Acad. St. Petersb. VI. Sci. Nat. 1: 155. 1834.

[17] Rév. Gram. 2: pl. 207. 1829.

written "Pipt. punctatum P de Beauv. Roem. et Schult. II 328?" The specimen belongs to *Eriochloa punctata* (L.) Desv.

ACICARPA, a new genus with a single species.

49. ACICARPA SACCHARIFLORA, *pl. 1. f. 4.* No locality is given. *Milium hirsutum* Beauv. pl. 5, f. 5., and Sloane Hist. Jam. 1: 43. pl. 14. f. 2. are cited. The specimen consists of two panicles and four leafy shoots of *Valota insularis* (L.) Chase. The Beauvois and Sloane figures cited also represent this species.

AGROSTICULA, a new genus with a single species.

51. AGROSTICULA MURALIS. *pl. 1. f. 2.* "In veteribus muris prope Rio-Janeiro." The specimen consists of a tuft with mature panicles half the length of the entire plant. The species belongs in *Sporobolus*, *S. muralis* (Raddi) Hitchc. & Chase, as described in the Grasses of the West Indies.[18]

59. AIRA BRASILIENSIS. "In veteribus muris prope Rio Janeiro." No specimen of this could be found. The description agrees in every way with the plants referred by Hackel[19] to *Sporobolus brasiliensis* (Raddi) Hackel, based on *Aira brasiliensis* Raddi. Other specimens representing this species are *Sellow*, Brazil, the type collection of *Eragrostis airoides* Nees, and *Hassler* 11560, Paraguay. This species is peculiar in having a second floret in about half the spikelets of most of the specimens. Because of these 2-flowered spikelets it has been placed in *Eragrostis*, but the lemmas are 1-nerved, not 3-nerved as in *Eragrostis*.

ARUNDINELLA, a new genus with a single species.

60. ARUNDINELLA BRASILIENSIS. *pl. 1. f. 3.* "In collibus apricis prope Rio Janeiro." No specimen of this could be found. Raddi's figure of the spikelet indicates unmistakably the genus recognized under this name. The description points to the common species of Brazil, *A. hispida* (Willd.) Kuntze (*Andropogon hispidus* Willd. 1805), to which it has been generally referred.

NAVICULARIA, a new genus including three species, the third of which, *N. lanata*, being figured, is taken as the type. The three species belong in *Ichnanthus* Beauv. (1812).

Raddi says the genus is distinguished by the peculiar and constant structure of the spikelet, which has three valves of the corolla as well as three of the calyx. The three valves of the corolla are the fertile lemma, its well-developed wings (characteristic of the genus *Ichnanthus*) and the palea; the three valves of the calyx, the two glumes and the sterile lemma.

[18] Contr. U. S. Nat. Herb. **18**: 368. 1917.

[19] Bull. Herb. Boiss. II. 4^3: 278. 1904.

61. NAVICULARIA HIRTA. "In saltibus montosis prope Rio-Janeiro." (The locality of this is given with that of *N. glabra.*) The specimen could not be found in Pisa but in the British Museum is a specimen bearing the name in Raddi's script. The plant agrees with Raddi's description and also with that of *Panicum loliaceum* Bertol.,[20] (not Lamarck, 1791) which Raddi cites, having pilose glumes and well-developed wings on the lemma, pubescent sheaths, and blades puberulent beneath. Bertoloni refers to the wings of the lemma as nectaries. This species was referred by Nees[21] to *Panicum candicans* Nees, but in that the appendages of the fertile lemma are reduced to scars.

Doell[22] reduces *Navicularia hirta* to "*Ichnanthus planotis* Trin." making it var. *β pilosus* Doell. Doell gives Trinius as the author of *I. planotis*, but Trinius[23] published it as *Panicum planotis.*

Trinius's description (including three varieties) seems to include more than one species. A specimen in the Trinius Herbarium named "*Panicum planotis* m. var *β*" by Trinius and labeled "Rio Janeiro 86" is like the Raddi specimen. Trinius's brief description of *β* agrees with this plant. A specimen named "*Panicum planotis* m. var. *α*," "Rio Janeiro 269" is a species of *Panicum*. This agrees with "Append. nullis" given in the diagnosis of var. *α*. Raddi's specific name is the earliest tenable one of this species: **Ichnanthus hirtus** (Raddi) Chase.

Schultes[24] changes *Panicum loliaceum* Bertoloni, not Lamarck, to *Panicum Bertolonianum* Schult.

Except the two specimens mentioned I have seen none which belong to this species.

62. NAVICULARIA GLABRA. "In saltibus montosis prope Rio-Janeiro." No specimen of this could be found. Hitchcock[25] interprets Raddi's description and publishes the name *Ichnanthus glaber* (Raddi) Hitchc. The specimen cited by Hitchcock, *Rose* 20181, "on Corcovado, Rio de Janeiro," agrees perfectly with Raddi's description.

63. NAVICULARIA LANATA. *pl. 1. f. 5.* "In herbidis prope Rio-Inhumirim." The specimen is an immature plant of *Ichnanthus leiocarpus* (Spreng.) Kunth (*Panicum leiocarpum* Spreng. 1820), the

[20] Opusc. Sci. Bologna **3**: 408. 1819.
[21] Agrost. Bras. 133. 1829.
[21] Mart. Fl. Bras. 2²: 280. 1877.
[23] Mem. Acad. St. Petersb. VI. Sci. Nat. **1**: 322. 1834.
[24] Mant. **2**: 240. 1824.
[25] Contr. U. S. Nat. Herb. **22**: 10. 1920.

panicle branches ascending instead of spreading as at maturity. This species is represented by *Botanic Garden Herb.* 3318, Trinidad, and *Riedel* 183, Bahia, Brazil.

64. OPLISMENUS BRASILIENSIS. "In montanis prope Tejucco, necnon in Monte Corcovado." The specimen consists of four simple plants of *Oplismenus hirtellus* (L.) Beauv. The sheaths are pubescent as in *Regnell* III 1373, from Brazil, and *Pittier* 5976, from Venezuela, as well as in numerous tropical North American specimens. The pubescence is rather soft, not stiff and bristly as in *Wright* 751, *Pringle* 76, and *Shafer* 3011, from Cuba; *Harris* 11465, 11607, from Jamaica; and *Hitchcock* 10222 and 10252, Tobago.

66. PANICUM UNCINATUM. "In sylvaticis prope Catumby, non procul ab Urbe Rio de Janeiro." No specimen of this could be found in Pisa, but in the herbarium of the British Museum is a specimen so named in Raddi's script. The upper spikelets are mature, showing the hooked, spine-like hairs. The plant is the same as the type of *Echinolaena polystachya* H. B. K., which was examined in the Berlin Herbarium. It is represented by the specimens cited under this name in Hitchcock's Mexican Grasses[26] and those cited under *Pseudechinolaena polystachya* (H. B. K.) Stapf in his Grasses of British Guiana.[27]

67. PANICUM PULCHELLUM. "In sylvaticis prope Catumby; non procul ab Urbe Rio de Janeiro." The specimen consists of a creeping plant with four flowering culms and another flowering culm without base. It belongs to the species described under this name in Hitchcock and Chase's North American Species of Panicum.[28]

68. PANICUM OLYRAEFOLIUM. *pl. 1. f. 6.* "In sepibus prope fossas udas in viciniis Rio-Janeiro" (the locality given with that of *P. donacifolium*). The specimen, consisting of two branching plants rooting at the nodes, and two additional flowering culms, belongs to *Panicum frondescens* Meyer, as described by Hitchcock and Chase.[29]

69. PANICUM CONDENSATUM. "In sepibus prope fossas udas in viciniis Rio-Janeiro." The specimen consists of a flowering culm, lacking the base, with sterile branches. Among the unidentified grasses in the Florence Herbarium were three sheets of this collection, the largest with a stout culm and blades reaching to 20 cm. long and 2.6 cm. wide. Raddi cites "Bert. Op. Sc. di Bol. An 1819. T. III p. 408." Bertoloni's description agrees well with Raddi's specimens.

[26] Contr. U. S. Nat. Herb. **17**: 223. 1913.
[27] Contr. U. S. Nat. Herb. **22**: 469. 1922.
[28] Contr. U. S. Nat. Herb. **15**: 123. 1910.
[29] Contr. U. S. Nat. Herb. **15**: 121. 1910.

Gaudichaud 288, Rio Janeiro, the type of *Panicum auriculatum* β *fasciculosum* Doell[30] and of *Panicum Januarium* Mez, and *Pabst* 706, from Brazil, both in the Berlin Herbarium, belong to *Panicum condensatum* Bertol. Of the eight collections cited by Mez[31] under *P. Januarium*, *Gaudichaud* 288, Rio de Janeiro, is taken as the type, because Mez cites "*Panicum auriculatum* var. *fasciculatum* Doell" (error for *fasciculosum*), and this is the only specimen Doell cites for the variety. The specimen in the Berlin Herbarium bears this name in Doell's script. The name in Mez's writing is not *Januarium* but one that was not published. The species belongs in *Hymenachne* Beauv. as described by Chase,[32] **Hymenachne condensata** (Bertol.) Chase. The species is represented in the U. S. National Herbarium by *Wilkes Expl. Exped.* 6, Rio Janeiro.

70. Panicum donacifolium. "In sepibus prope fossas udas in viciniis Rio-Janeiro." The specimen consists of two flowering culms, both lacking the base, with auriculate-clasping blades. It belongs to the species at present known as *Hymenachne auriculata* (Willd.) Chase,[33] or *Panicum auriculatum* Willd.,[34] the type specimen of which, labeled "Amer. merid. Humboldt," was examined in the Willdenow Herbarium in the Berlin Herbarium. Since Raddi's name is earlier it must replace that of Willdenow, **Hymenachne donacifolia** (Raddi) Chase. This species is represented in the U. S. National Herbarium by *Smith* 2748, Santa Marta, Colombia; *Eggers* 14633, Balao, Ecuador; *Goeldi* 52, Para, Brazil: and *Morong* 693, Paraguay.

Panicum cordatum Doell,[35] the type of which, *Glaziou* 4326, Rio de Janeiro, so named in Doell's script, was examined in the Berlin Herbarium, belongs to this species.

71. Panicum paspaloides. "Ad fossas udas prope Rio-Janeiro." The specimen belongs to *Panicum geminatum* Forsk. as described by Hitchcock and Chase,[36] North American Species of Panicum.

72. Panicum divaricatum. "In sepibus proximus Rio Janeiro, ut etiam alibi, praecipue ad fossas udas." Raddi does not publish this as his own species, but gives Linnaeus as author. The specimen is *Lasiacis ligulata* Hitchc. & Chase.[37]

[30] Mart. Fl. Bras. 2²: 238. 1877.
[31] Bot. Jahrb. Engler **56**: Beibl. **125**: 4. 1921.
[32] Proc. Biol. Soc. Washington **21**: 1. 1908.
[33] Proc. Biol. Soc. Washington **21**: 5. 1908.
[34] Spreng. Syst. Veg. **1**: 322. 1825.
[35] Mart. Fl. Bras. 2³: 239. 1880.
[36] Contr. U. S. Nat. Herb. **15**: 30. 1910.
[37] See Hitchcock's revision of Lasiacis, Contr. U. S. Nat. Herb. **22**: 18. 1920.

73. PANICUM MACROPHYLLUM. "Juxta torrentes in vicinis Mandioccae, et in Montibus Estrellensibus." The specimen is mounted on two sheets, one of three leaves, the sheaths overlapping, the blades 30 cm. long and 8.8 cm. wide; the other (evidently the summit of the same culm) with two leaves, the upper blade much reduced and split to the base, and a panicle 18 cm. long and 7.5 mm. wide. The spikelets are crowded, 2.3 mm. long, the glumes and sterile lemma subequal, the lemma slightly longer, acute, scabrous on the nerves and pubescent near the margins, the sterile palea nearly as long as its lemma; the fruit is elliptic, subacute, smooth and shining, 1.8 mm. long, 0.6 mm. wide. The species is allied to *Panicum latissimum* Mikan and *P. secundum* Trin. It differs from the first in the strict panicle branches and the equal glumes, and from the latter in the much broader blades. I have seen nothing like Raddi's specimen except Jardim Botanico do Rio Janeiro no. 575 (no locality but "Brasil") in the U. S. National Herbarium. This differs from the type in having sheaths sparsely appressed-pilose, and somewhat firmer blades, which are split as is the upper blade in Raddi's specimen.

75. PANICUM PURPURASCENS. Raddi states that it grows with the preceding (*Panicum maximum* Jacq.) which is cultivated throughout the province of Rio Janeiro and is also found growing spontaneously. The specimen consists of a flowering culm, lacking the base, of *Panicum barbinode* Trin., as described by Hitchcock & Chase.[38] The panicle is somewhat purplish.

77. PANICUM RUDGEI (β) BRASILIENSE. "Species rarissima observata tantum in vicinis fluminis Inhumirim, in locis silvosis et herbosis." The specimen consists of two pieces, one of four panicles, three axillary and a terminal one close together, each exceeded by its blade; the other of a single panicle and leaf. The specimen belongs to *Panicum Rudgei* Roem. & Schult. as described by Hitchcock and Chase.[39] The nodes are slightly geniculate as noted by Raddi.

83. SETARIA SULCATA. "In marginibus fossarum udarum prope Catumby, non procul ab urbe Rio de Janeiro." The specimen is an entire rather small plant, the nodes and junction of sheath and blade yellowish hirsute, the broadest blade 18 mm. wide, deeply pleated, the panicle scarcely 2 cm. wide. It belongs to *Chaetochloa poiretiana* (Schult.) Hitchc. as described in Hitchcock's recent revision of Chaetochloa.[40] On the ticket is written in Raddi's script "*Setaria sulcata* nob., *Panicum sulcatum* Bert."

[38] Contr. U. S. Nat. Herb. **15**: 33. 1910.
[39] Contr. U. S. Nat. Herb. **15**: 139. 1910.
[40] Contr. U. S. Nat. Herb. **22**: 159. 1920.

Raddi cites "Bert. Excerpta de Re Herb. 14." This paper is not in the library of Washington. In another paper the same year[41] Bertoloni published *Panicum sulcatum* Bertol., citing Raddi's collection from Brazil. This is apparently described independently of *P. sulcatum* Aubl. 1775. *Glaziou* 17396, Rio Janeiro, though a larger plant, is very like Raddi's specimen.

86. POA BRASILIENSIS. "In sepibus prope Rio de Janeiro." The specimen could not be found. The description is as follows: "panicula elongata stricta, ramis alternis adpressis, spiculis lineari-lanceolatis subdecemfloris, valvula corollae interiore margine brevissime ciliata; foliis bi-aut tripollicaribus, acuminatis, rigidis, margine involutis, ligula nulla. *nob.* Gramini tremulo affine, paniculatum elegans majus, spicis minoribus et longioribus. *Sloan, H. J. p. 113. t. 71. fig. 1?* (mala)."

The original of the Sloane figure in the British Museum of Natural History was examined by Dr. A. S. Hitchcock in 1907. It is *Eragrostis cubensis* Hitchc., which is not found in Brazil.

Nees[42] transfers *Poa brasiliensis* Raddi to *Eragrostis* "excl. synon. Sloanei." and refers *E. bahiensis* Schrad.[43] to it as a form with blades ciliate at base. Short-leaved specimens of this species, such as *Capanema* 5379, and 5386, Brazil, agree well with Raddi's description. The ligule is not wanting as stated by Raddi, but is very minute.

89. MEGASTACHYA SWAINSONI. "Species rarissima, quam mihi benevole communicavit D. Swainson red. ex itinere Pernambucano ad Urbem Rio-janeiro." The specimen is a small tuft of *Eragrostis maypurensis* (H. B. K.) Steud., with small, somewhat capitate panicles, as in Jardim Botanico do Rio de Janeiro no. 5535, collected by Luetzelburg; 3742, collected by Löfgren, and 5382 collected by Capanema.

BOTANY.—Opsiandra, *a new genus of palms growing on Maya ruins in Petén, Guatemala.* O. F. COOK, Bureau of Plant Industry.

A palm that grows in the ruined Maya cities of Petén apparently has not been described. The ruins are buried in the forest, with palms and other trees often growing upon the terraces, walls, or roofs of the buildings. The chief center of the early Maya civilization, in the district of Tikal, Uaxactun, Nakum, and Naranjo, is supposed to have been abandoned about fifteen centuries ago, and now is completely

[41] Opusc. Sci. Bologna **4:** 230. 1820.
[42] Agrost. Bras. 497. 1829.
[43] In Schult. Mant. **2:** 318. 1824.

overgrown with tropical vegetation. The outlook from the high pyramids in all directions is an undulating, unbroken forest. The present conditions are to be considered as a result of reforestation, not only of the sites of the cities, but probably of the whole surrounding region. It is a regular consequence of the primitive system of agriculture to reduce a forest country to an open, fire-swept grassland.[1]

Though tropical forests are restored rapidly in small clearings, the reforestation of an extensive grassland necessarily is very gradual, with a long succession of different conditions and types of trees to be established and replaced before there can be a complete return to the original state of the undisturbed, or "virgin forest." Some elements of the forest flora come in very slowly, even after apparently favorable conditions have been established. Thus there may be new forests with no palms in the undergrowth, though several kinds of palms may be found in older forests near by. In more advanced stages of reforestation palms may be abundant, but represent only a few species, which is true of the forests of Petén.[2]

The rapid destruction of the ancient cities by the forest, now to be witnessed in the Petén region, is evidence against the idea of very great antiquity, estimated by some archaeologists in thousands of years. In view of the damage now being done by the growth and uprooting of large trees, it does not appear that many centuries will be required to reduce all of the massive structures to shapeless mounds. The destruction tends, no doubt, to accelerate as the soil deposits accumulate among the loosened stones and the trees grow to larger size before uprooting. Several centuries may have passed after the cities were abandoned before they were covered by the forest. The dates that have been deciphered from the sculptured monuments are from a period corresponding to the early centuries of the Christian Era; though doubtless the city-building age was preceded by a long period of agricultural development. The Maya system of chronology used in dating the monuments would go back to about 3500 B.C.

The new palm would not be classified ecologically with the undergrowth species, but as a true forest type, growing to the same height as many other trees. It has a rather slender trunk, about 6 inches in

[1] See "Milpa Agriculture, A Primitive Tropical System," Smithsonian Report for 1919, pp. 307–326.

[2] Of the undergrowth species an *Acanthorhiza* is by far the most abundant, two species of *Chamaedorea* (*C. elegans* and *ernesti-augusti*) are common, and three others of occasional occurrence. Two large forest palms are also very common in some localities, *Attalea cohune* and a very tall, slender palmetto, locally known as *botán*. The *taciste* palm, a species of *paurotis*, grows in open places and survives burning over.

diameter, supported on a solid conical mass of thick roots, and attaining a height of 60 feet or more. The leaves are large and pinnate, but few in number, usually only 5 or 6, with a total length of 8 or 9 feet, and about 90 pinnae on each side of the midrib. The inflorescences are several joints below the leaves, with the branches robust and mostly simple, and ripening into large clusters of red cherry-like fruits, like those of *Synechanthus*.

As the Tikal district is now entirely uninhabited, no uses of the palm were learned, and the only name to be learned was *palma cimarrona*, or "wild palm." At El Cayo, in British Honduras, one informant gave *cambo*, or *kambo*, as the Maya equivalent of *palma cimarrona*. But the palm was not noticed in the vicinity of El Cayo, nor along the Belize River, though it was seen at several places on the road between Flores and Benque Viejo, as well as in the forests to the northward.

Since the fruit and floral characters are those of the Synechanthaceae the new palm may be assigned to this family, which includes only three other genera, *Synechanthus* in Guatemala, *Gaussia* in Cuba, and *Aeria* in Porto Rico. The tall trunk would associate *Opsiandra* with the West Indian genera, but there is no such swelling of the lower part of the trunk as in *Aeria*. Also, *Opsiandra* has 4 spathes, instead of 7 as in *Aeria*, or 2 as in *Gaussia*. Between *Opsiandra* and *Synechanthus* there is little external resemblance, the latter being a short-trunked undergrowth palm with clustered pinnae and slender, fastigiate inflorescence-branches.

Diagnostic features of *Opsiandra* are the tall, columnar trunk, the infrafoliar inflorescences, the 4 short, narrow spathes, the thick simple branches of the spadix, the flowers only 2 or 3 in each cluster, the petals thick and valvate in both sexes, the persistent staminate buds, and the transversely reniform seeds, with uniform albumen and a central cavity. The most striking peculiarity is that the inflorescence branches are robust and simple, while in the other genera the branches have numerous slender divisions and the flowers more definitely in rows.

The technical characters of the new genus may be summarized as follows:

Opsiandra Cook, gen. nov.

Trunk solitary, erect, ascending or flexuous, columnar below, slightly and gradually tapering above, scarcely enlarged at the base, supported by a conical mass of very thick roots.

Leaves few, usually 5 or 6, ascending, 2 to 3 meters long, with a cylindrical sheathing base; petiole distinct, deeply channelled below and with strongly

incurved margins above; pinnae numerous (88 pairs), lanceolate, not clustered or grouped, attaining a length of about 60 cm. and a width of nearly 4 cm.

Inflorescences distinctly infrafoliar, slender, with numerous (15 to 30) rather robust, simple, tapering branches, or a few of the lower branches forked near the base.

Spathes 4, slender, incomplete; 3 upper joints of the peduncle without spathes. Lowest spathe short and strongly bicarinate; third and fourth spathes longest, but not attaining the base of the branches of the matured inflorescence.

Flowers of one form externally, in longitudinal rows of 2 or 3, the lowest flower of each group pistillate, somewhat smaller than the staminate flowers, also a few solitary staminate flowers near the ends of the branches; sepals rounded, broadly imbricate; petals broadly triangular, valvate, somewhat longer than broad, thick, fleshy, persistent, becoming leathery in the ripe fruit; stamens 6, on broad short filaments; pistillodes columnar or variously compressed, sharply apiculate, nearly as long as the anthers; pistillate flowers with rudimentary staminodes, the pistil sharply trigonal, on each face a distinct median groove, the mature stigmas divaricate, persistent at the base of the ripe fruit; also some of the staminate buds persistent through the fruiting period.

Fruits globose-reniform, with a distinct groove on the median face above the stigma, color light green, turning to deep red when ripe, with a smooth skin and a soft fleshy pericarp, enclosing a somewhat depressed or subreniform seed. Surface of seed nearly smooth, slightly impressed with 5 to 7 simple or sparingly branched or anastomosing fibers rising from the inner or median side of the hilum, passing over and around the seed and converging toward the embryo; albumen uniform, with a central cavity; embryo about intermediate between basal and lateral, on the outer side of the seed away from the stigma; embryo cavity about half as broad as long, extending more than half-way to the central cavity.

Seedling with three bladeless sheaths, followed by two leaves with simple bifurcate blades.

The generic name refers to the persistence of the staminate flowers and buds which are to be found in fresh condition on the same inflorescences with ripe fruits. This may indicate an extreme condition of proterogyny or a continued production of staminate flowers through a long period. Monoecious palms may be considered as proterogynous if the stigmas are exposed before pollen is shed from the staminate flowers of the same inflorescence. Drude alludes to the opposite relation, of female flowers developed after the male flowers have withered. The difference usually would be only a few hours, or at most a few days, whereas several weeks must be required, or possibly months, for the fruits of *Opsiandra* to grow and ripen, while staminate buds and flowers are still present.

Opsiandra maya Cook, sp. nov.

Trunk attaining 20 meters and upward, about 15 cm. in diameter near the base, tapering slightly and gradually; internodes 12 to 15 cm., becoming shorter above, separated by distinct rings. Superficial roots 3.5 cm. thick, forming a dense conical mass supporting the trunk.

Leaves 2 to 3 meters long; sheath and petiole not distinct, the strictly sheathing portion about 30 cm. long, the petiole about 65 cm., very deeply channelled below, with thin strongly incurved margins to within about 15 cm. of the lowest pinnae, there the groove becoming shallow and the margins rounded. Sheath 1.5 cm. thick at the back, the petiole becoming thicker above and the groove more shallow; diameter of petiole above 3 cm. Rachis sharply carinate above.

Pinnae 88 on one side of the midrib; lowest pinna 41 cm. by 2.2 cm.; second pinna 47 cm. long; largest pinna somewhat below the middle, 61 cm. by 3.8 cm.; fifth pinna from the end 32 cm. by 2.7 cm.; subterminal pinna 22 cm. by 1.3 cm.; terminal pinna 16 cm. by 0.5 cm., or the two last pinnae united with total width of 1.5 cm. One vein on each side of the midrib more prominent than the others, especially underneath, also 5 or 6 less prominent veins, separated by 6 or 7 subequal veinlets; in dry specimens the spaces between the veinlets showing many short translucent longitudinal lines, not in regular rows; submarginal vein delicate, separated from the margin by 3 or 4 veinlets very close together; margin thickened and veinlike, but the edge thin.

Inflorescence 75 cm. long; from lowest branch to tip 34 cm. Branches 17 or 18, about 0.4 cm. thick, at base nearly 0.5 cm. tapering gradually to the tip, attaining 30 cm. The lowest 4 branches divided near the base; terminal portion 21 cm. Peduncle with 7 joints measuring respectively 2, 11, 7.5, 12, 11, 5, and 3 cm., the last 3 joints without spathes.

Spathes 4, the lowest 9.5 cm. by 5.5 cm., distinctly carinate on each side, deeply bidentate, the tips triangular-pointed, 3 cm. long; second spathe 13.3 cm. by 4.3 cm., slightly carinate, but sharply angled at the sides; like the others; third spathe 19.5 cm. by 2.4 cm.; fourth spathe 19 cm. by 2.1 cm., attaining within 2 to 3 cm. of lowest branch, the fruiting portion emerging from the spathes long before flowering.

Sepals about 1 mm. long; petals of female flowers at anthesis about 2 mm. long, on ripe fruits 3 mm. long, thick; anthers 1 mm. long, and pistillodes nearly the same length, staminodes rudimentary.

Fruits subglobose or transversely subreniform, somewhat flattened on one side and with a vertical groove above the stigma, 1 cm. to 1.5 cm. in diameter, with a soft fleshy red pericarp 2 mm. thick, the flesh of green fruit mucilaginous and very sticky; seed 0.9 cm. to 1.1 cm. in diameter, somewhat irregular in shape, subglobose, oblong, reniform, oval, or unsymmetrical, the surface smooth or slightly uneven, marked with a few impressed fibers; central cavity of the seed often strongly depressed, 2 to 4 mm. in diameter, surrounded by a wall of uniform rather hard albumen 2.5 to 3 mm. thick.

Seedlings with the three bladeless sheaths measuring respectively, 7 cm., 2.5 cm. and 5 cm. in length, in diameter about 0.5 cm.; first two sheaths without chlorophyll, white at first but soon brown and decayed; first two leaves simple, deeply bifid, the divisions measuring 12 to 13 cm. by 1.3 to 1.9 cm.

Type in the U. S. National Herbarium, nos. 1,084,215–1,084,219, consisting of leaf parts, inflorescence, and spathes from a single individual growing at Laguna Colorada, Tikal District, Petén, Guatemala, altitude 100 to 500 meters, March 23, 1922, by O. F. Cook and R. D. Martin (no. 94), of which photographs and complete leaf measurements were obtained. Ripe fruits were collected a few days later near Uaxactun, on a larger inflorescence, with more numerous branches and the fruits more abundant and crowded. The seeds of this cluster were brought to Washington and planted in a greenhouse, where the seedlings have grown well.

Young palms were noted among the ruins of Nakum with petioles much longer and more slender than those of the adult palm at Laguna Colorada. Also, in the young palms the pinnae are relatively broader than in the adult, 1.5 to 2 cm. wide with a length of 18 to 20 cm. An injured leaf of a young palm growing on a ruined temple at Uaxactun showed a special enlargement of the basal pulvini, so that the pinnae stood nearly at right angles to the rachis instead of the usual angle of about 50 to 60 degrees in young palms, or about 40 degrees in adults.

Since northern Petén has a dry season sufficiently long and severe to throw most of the vegetation into a dormant condition, it seems not unreasonable to expect that *Opsiandra* may prove somewhat resistant in more temperate climates and possibly adapted to household cultivation or to outdoor conditions in Florida or California. As a popular name the expression "Maya palm" might be used, in view of the habitat and frequent association with the ancient ruins.

ZOOLOGY.—*A new frog of the genus* Leptodactylus.[1] DORIS M. COCHRAN, National Museum. (Communicated by Dr. L. STEJNEGER.)

A collection of reptiles and batrachians recently sent to the United States National Museum by Dr. W. L. Abbott contains an interesting new frog, of which I have prepared the following description:

Leptodactylus dominicensis, sp. nov.

Diagnosis.—Toes without distinct dermal margins; tongue heart-shaped; tympanum half the width of the eye; vomerine teeth in two long curved series behind the choanae; snout pointed, depressed, with a sharp edge.

Type.—U. S. N. M. No. 65670, Las Cañitas, Dominican Republic; February 25, 1923; Dr. W. L. Abbott, collector.

Description of type specimen.—Vomerine teeth in two long curved series beginning behind the middle of the choanae, separated by the width of the choanae; tongue moderate in size, heart-shaped; snout pointed, depressed, sharp-edged, declining rapidly from the eyes to the tip; when viewed in profile, upper lip projects considerably beyond lower lip; canthus rostralis sloping and very indistinct; nostrils a little nearer to end of snout than to eye; tympanum longer than high, its greatest diameter very slightly more than half the diameter of eye; interorbital space equals width of upper eyelid; first finger much longer than second, which equals fourth; toes slightly webbed at base; third much longer than fifth; subarticular tubercles well developed; numerous smaller tubercles in series on the sole; two metatarsal tubercles, the inner connected with a very distinct tarsal fold; heels just touching when hind limbs are folded at right angles to axis of body; tarso-metatarsal joint reaching anterior border of tympanum when hind limbs are carried forward along the body; skin smooth above and below; numerous small, pointed glands on the outer surface of the tibia; a narrow dorso-lateral glandular fold, and a few elongate glands on the sides; a strong glandular fold from posterior angle

[1] Published by permission of the Secretary of the Smithsonian Institution.

of eye over tympanum to shoulder; ventral disk plainly marked by dermal folds.

Dimensions.—Tip of snout to vent, 36 mm.; tip of snout to posterior edge of tympanum, 13 mm.; greatest width of head, 13 mm.; fore leg from axilla, 19 mm.; hind leg from vent to heel, 26 mm.; hind leg from vent to tip of fourth toe, 49 mm.

Coloration (in alcohol).—Body dark bluish-gray above, becoming lighter on the sides; the sharp rim on the snout white; the head dark gray with a blackish bar between the eyes; a black band from eye across tympanum to shoulder; arms and legs light with darker bands and markings; a white line on the posterior femur; underside whitish, the throat finely sprinkled with pale gray.

Remarks.—This frog is closely related to *Leptodactylus albilabris* from Porto Rico. The snout is shorter and broader, and the projecting edge on the upper lip is far more pronounced. Then, too, the hind legs are shorter, and the examination of the mouth reveals a deeply incised tongue, while the tongue of *L. albilabris* is only slightly nicked behind.

ZOOLOGY.—*A new lizard of the genus* Sceloporus.[1] DORIS M. COCHRAN, National Museum. (Communicated by Dr. L. STEJNEGER.)

While identifying the lizards collected in Mexico by the Biological Survey and now in the United States National Museum, I came upon a species of *Sceloporus* which seems to be new to science.

Sceloporus nelsoni sp. nov.

Diagnosis.—Lateral scales directed obliquely upwards and backwards, and passing gradually into the dorsals; series of femoral pores widely separated, not meeting on the preanal region; tail strongly compressed; head-shields smooth; two rows of granular scales between supraoculars and supraciliaries; femoral pores 15 to 20.

Type.—U. S. N. M. No. 47676; Plomosas, Sinaloa, Mexico; July 18, 1897; Nelson and Goldman, collectors.

Description.—Head-shields smooth; frontal ridges fairly prominent; frontal transversely divided, in contact with the interparietal, which is a little broader than long; a single large parietal shield on each side of the interparietal; fronto-parietals in contact with last two supraoculars; two canthal scales; five transverse supraoculars, bordered inwards by an incomplete series of small scales, and separated from the supraciliaries by two rows of almost granular scales; five scales, not larger than those before them, form a denticulation on the anterior border of the ear; dorsal scales much larger than ventrals, strongly keeled, mucronate, forming slightly converging series; 35 scales between the interparietal shield and the base of the tail; 9 scales, taken in the middle of the back, correspond to the length of the head; ventral scales small, smooth, bi- or tricuspid; about 36 scales around the middle of the body; the adpressed hind limb reaches between ear and eye; tibia as long as distance between end of snout and ear; the distance between base of

[1] Published by permission of the Secretary of the Smithsonian Institution.

fifth toe and extremity of fourth exceeds the distance between end of snout and posterior border of ear; 15 femoral pores on each side; tail distinctly compressed; caudal scales larger than dorsals, strongly keeled and mucronate except those on basal third underneath, which are smooth; males with slightly developed post-anal scales.

Coloration (in alcohol).—Bronze-colored above; a broad, dark stripe along each side with a light area above; a black vertical bar in front of the shoulder; head reddish brown spotted with darker; lips with dark vertical bars; a very noticeable black spot encircled with a ring of light yellow on the posterior margin of the parietal shield, not involving the "pineal eye"; throat with oblique bluish bands converging posteriorly; breast yellowish; sides of belly pale green, broadly edged with blackish blue near the median ventral line.

Dimensions.—Snout to vent, 56 mm.; shielded portion of head, 13 mm.; snout to ear, 14 mm.; length of fourth toe, 15 mm.

Remarks.—Although the new species resembles *Sceloporus pyrocephalus* Cope in many of its characters, there are several striking differences which will enable the two species to be distinguished immediately. The black spot on the parietal shield, which in *S. pyrocephalus* encircles the "pineal eye," in *S. nelsoni* is on the extreme posterior border of the parietal, not involving the pineal eye, and is itself encircled by a ring of light color which becomes slightly darker just anterior to the black spot. The snout is quite flat in *S. pyrocephalus;* one row of regular scales separates the supraoculars and the supraciliaries. In the new species the frontal ridges are fairly prominent; there are two irregular rows of small scales separating supraoculars and supraciliaries; the dorsal scales are larger and more spiny, and the femoral pores are more numerous. The ventral coloration of the two species is entirely different—in the males of *S. pyrocephalus* there is a startling black and white herring-bone pattern of convergent stripes, while in the *S. nelsoni* the pale blue areas on the sides are simply edged with black, as in the large majority of the *Scelopori.*

In addition to the type, there are 10 specimens in the National Museum, five from near Mazatlan, one from Culiacan, three from Rosario and one from Barranca Ibarra. The coloration is constant, except that the specimens from near Mazatlan are somewhat lighter. The femoral pores vary in number between 15 and 20.

The new species is named in honor of Dr. E. W. Nelson, Chief of the Biological Survey.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BOTANICAL SOCIETY

158TH MEETING

The 158th meeting of the Society was held at the Cosmos Club at 8 P.M., Tuesday, March 7, 1922, 66 members and guests being present.

Dr. A. D. HOPKINS was elected to membership.

Under Brief Notes and Reviews of Literature, Dr. A. S. HITCHCOCK showed the Society a sample of paper from bamboo, the paper having been made in France. He stated that no paper in the United States was made from a grass.

Dr. RUDOLF KURAZ, Agricultural Attache and Secretary to the Czecho-slovak Legation gave an address on *Agriculture in Czechoslovakia, and the achievements of the Czechs in American agriculture.* At the close of the regular program, two motion pictures were shown by Dr. KURAZ, one on Prague, the capital city, and the second on the national Sokol.

Prof. DAVID LUMSDEN addressed the Society on *Raising orchid seedlings by the use of a mycorrhizal fungus.*

The presence of endophytic fungi in the roots of certain plants of the order Orchidaceae has been described by several authors. It was Link[1] who first observed them in the protocorm of *Goodyera procera,* an orchid native to India and Malaya. He did not attempt to describe the fungus, merely stating that the cells were filled with a colorless granular material which later disappeared.

The term mycorrhiza was used first by Frank[2] in 1885 to describe the infection of the roots of a plant by a fungus. It was not however until 1903 that serious consideration was given to the reasons for the affinity existing between an orchid and a fungus. During the year 1909 Hans Burgeff contributed a valuable publication, "Die Wurzelpilze der Orchideen" dealing on the subject. The same year Noel Bernard published an article showing that when the seeds were sown under aseptic conditions the embryos swelled and formed green spherules and finally died; when sown on pure cultures of the endophytic fungus isolated from the roots of these plants, the embryo developed normally, forming a spheroid body which soon produced a cotyledon and papillae with long root hairs.

Further investigation conducted by Bernard and Burgeff at that time showed that the germination of orchid seed did not occur except in the presence of the root fungi.

The speaker having studied very closely the methods pursued by Bernard and Burgeff carried out numerous experiments with several genera and species of orchidaceous plants to ascertain the value of fungoid infection in the germination of orchid seeds. Cellulose, starches, agar and other nutrients were also used as mediums on which to germinate the seed.

Various kinds of wood kept under normal and abnormal moisture conditions were also used. The most satisfactory results were obtained when the seeds were sown in 4 to 5 inch flower pots, containing 50 per cent osmunda fiber;

[1] H. F. Link. Icones selectae anatomico-botanicae II p. 10, t. VII, 1840.

[2] A. B. Frank. Ueber die auf Wurzelsymbiose beruhende Ernahrung gewisser Baume durch unterirdische Pilze Ber. d. deutsch. bot. Gesell. III. pp. 128-145 (1885) Lehrbuch der Botanik Bd. I (1892) p. 264.

50 per cent sphagnum moss, the medium being covered over with fine woven clean burlap and the flower pot when prepared being thoroughly sterilized in an autoclave. The third day after sterilization, if no infection manifested itself, the rhizoctonia was introduced to each of the experimental pots. Check pots were also kept for comparison. Moisture conditions were maintained by placing saucers of water in the propagating frame. A temperature of 80° to 85°F. with a relative humidity test of 75 to 82 per cent was maintained. The speaker had a few seedlings appear promiscuously on a few of the check pots which had not been infected. This may have been due to contamination as the check pots were placed side by side with those infected with the fungus.

While several nutrient solutions were used, including Pfeffer's, Burgeff's, and Crones', the culture giving the most satisfactory results was the one recommended by Burgeff, which is here given.

Burgeff's solution

	grams
Potassium dihydrogen phosphate	1.0
Calcium chloride	0.1
Sodium chloride	0.1
Magnesium sulfate	0.3
Iron chloride	0.01
Ammonium chloride	0.5
Distilled water	1000.0

Other nutrient solutions such as sugars, from 1 to 2 per cent solutions, glucose gelatin and non-liquefiable nutrient (potato) were also used in the experiment.

Roots growing in the air and roots from potted plants were utilized in making inoculations. The roots before using for inoculation and the seeds before being sown were subjected to sterilization by immersion for 2 to 3 minutes in a 7 per cent solution of calcium hypochloride.

Small pieces of the orchid root about $\frac{1}{8}$ inch long were used and transferred to the Petri dishes and test tubes containing the nutrient agar. In the cases of the flower pots, the small sections of the roots containing the rhizoctonia were placed under the burlap.

Out of a series of several hundred cultures only two organisms occurred with any noticeable regularity. Average contamination was manifest both in the test tubes and also in the flower pot method.

It is the opinion of the speaker that orchidaceous plants having a long line of ancestors and being the most specialized of all plants are necessarily dependent on other than ordinary food and environmental conditions which govern the life cycle of the masses of the lower plants. The orchid seed is very minute and devoid of endosperm. It has therefore acquired the habit of depending on the various root fungi for its early existence.

Further investigation with a large number of generic crosses demonstrated that a separate organism is required for a particular genus and possibly for particular species. As some results were obtainable under aseptic conditions it can not be said that the fungus is entirely essential but it is incontestable that the rhizoctonia promotes the germination of the seeds. It is nevertheless true that its presence is not indispensable and that a satisfactory germination can be obtained without its introduction.

Symbiosis opens up a wide field for investigational work and progress along this line is reaching more definite conclusions and perhaps we may find that a "well balanced ration" or the proper proportioning of plant food in each case for genera and species will reveal the "undiscovered secret of

nature" if so we may term it. For the present, investigation rather shows the affinity between the orchid seed and the fungi to be one of mutual parasitism rather than mutual symbiosis.

E. T. Wherry concluded the program by remarks on the *Cultivation of our native orchids with special reference to their relation to soil activity.*

159th meeting

The 159th meeting of the Society was held at the Cosmos Club, Tuesday, April 3, 1922, at 8 P.M. with President Safford in the chair and 55 members and guests present.

Dr. A. S. Hitchcock showed specimens of rattan from China. This rattan palm was very bad for travelers, on account of the spikelets. He also showed samples of wild rice from southeastern China, which he stated were the prototypes of cultivated rice.

Dr. N. A. Cobb gave an illustrated address on *The coconut industry, its economic importance, and a serious disease of the coconut caused by a nematode.*—The coconut industry is a very large one, but its size and importance are frequently not appreciated, even by experts. The coconut enters into the manufacture of soaps as an oil, into milk as a filler, while it is well known as a food, and used in cake frostings, cookies and candies. The dried meat of the coconut is the copra of industry. Thousands of miles of sea coast in the tropics are adapted to the growing of coconuts.

Fifteen years ago a disease was reported from Tobago and Trinidad, which came to be known as the coconut root disease. No one at this time realized that a nematode was the cause of this disease. Only a few years ago the first nematode was obtained from a diseased coconut by a Mr. Nobb, of the Imperial Dept. of Agriculture of the West Industries, though he did not at first recognize it as the causal agent of the disease. The identification of the nema and the proof that it caused the root disease was made by Dr. N. A. Cobb of the U. S. Dept. of Agriculture. The nema was determined to be a hitherto unrecognized species and was given the name *Aphelenchus cocophilus,* and the disease later came to be known as Red Ring of the coconut.

An estimate of the number of nemas in a single foot length of a coconut root shows about 20,000 present. The address was finely illustrated by colored slides of various nemas, as well as the sick and dying coconut palms, infested with *Aphelenchus cocophilus.*

160th meeting

The 160th meeting of the Botanical Society of Washington was held at the Cosmos Club, Tuesday, May 2, 1922 President, W. E. Safford presiding.

Dr. Tyozaburo Tanaka spoke on the *Citrus fruits of Japan, with notes on their history and the creation of new varieties by bud variation.* The orange goes back into Japanese mythology. Foreign citrus were introduced into Japan, as early as the first century. The general extent of the culture of the most important species and varieties of citrus grown in Japan were discussed. Several cases of the origination by bud variation of the variety Wase from the variety Owari were observed during recent citrus studies in Japan.

Dr. H. L. Shantz gave an illustrated talk on the *Botanic Gardens of South Africa.* The National Botanic Gardens of South Africa at Kirstenbosch, the best known in that part of the continent, were visited by the Smithsonian African Expedition in August 1920. The Gardens are supported largely by

private subscriptions from individuals, and the Botanical Society of South Africa, by the Cape Town Government, and by a grant from the South African government, though considerable income is secured by the sale of wood and by products from the Gardens.

The Gardens are situated on the side of Table Mountain. A large portion of it is relatively level, but at the back it slopes up to the top of the mountain, thus affording a great diversity of slope and elevation. The most interesting fact about the gardens is that their primary purpose is to bring together the native flora of South Africa, so far as possible, rather than to show a fine collection of exotic plants. Chief of note among the gardens is the Cycad amphitheatre, which contains probably the largest collection of these plants in the world. There were interesting collections of *Stangeria* and *Encephalartos*. Additions to the cycads have been made from America and Australia.

At another place nearby is the Aloe Garden or Kopje, represented by many genera and containing many of the more beautiful species from all over South Africa. Then there is the Bulb Garden, the Fern Dell, the Bolus Orchid Garden, and the Pelargonium and Protea collections.

Mr. R. H. Comton, Director of the Gardens, is also Professor of Botany at the University of Cape Town.

The Gardens at Lorenco Marques, in Mozambique, were also visited. This beautiful garden contains many of the finest of the East African plants as well as many exotics, and was developed largely by Thomas Honey and Senor Almeida. There is also a very attractive botanic garden at Pretoria, under the direction of the Botanical Department, of which Mr. I. B. Pole-Evans is the head. Here there was a specially interesting collection of xerophytic plants.

162D MEETING

The 162d meeting of the Botanical Society was held at the Cosmos Club at 8 p.m., November 7, 1922, with Dr. L. C. CORBETT, newly elected president, in the chair and 84 persons present. PHILIP BRIERLEY and Dr. A. G. JOHNSON were elected members.

Under Brief Notes, Mr. P. L. RICKER spoke of the proposed Mt. Hamilton Botanical Garden site, and suggested that a leaflet be prepared by the Botanical Society and the Wildflower Society and sent to members and others interested in the project. Dr. A. S. HITCHCOCK was authorized to present the matter of the proposed National Botanic Garden to the Botanical Society of America at their Boston Meeting.

Dr. A. S. HITCHCOCK spoke of finding in the Island of Hainan and in Indo-China a rare grass, *Chloris tenera*, originally described as *Cynodon tener* Presl. The grass was said to have been collected by Haenke at Sorzogon on Luzon in the Philippines. Dr. E. D. Merrill, Director of the Philippine Bureau of Science, had thought that this species was erroneously credited to the Philippines, as it was not known to occur in the Islands; and that it was probably a native of America. The Melaspina Expedition, to which Haenke was attached, had visited the western coast of America from Chile to Alaska before going to the Philippines. The specimens now at Prague are labelled incompletely and in some cases the locality is erroneous or even lacking. Since Dr. Hitchcock's visit to the Orient, Dr. Merrill has seen specimens of this species from near the type locality, thus confirming Haenke's original statement.

Program: Dr. W. A. Orton: *Physiatric botany* (illustrated). The history of diet is divided into three periods, ancient, medieval, and modern. The medieval period is the one of the chemical view of foods. The modern is the Biological Period. It began about 1900 with the recognition of the importance of vitamines. Vegetables are important in the diet. Especially is this true in the cases of diabetes, nephritis, and other similar diseases. Many kinds of vegetables are available to furnish adequate variety to the diet.

Dr. F. E. Kempton: *Barberry eradication in the United States.* Barberry eradication began in Europe in 1795. Satisfactory results were obtained. The American wheat rust epidemics of 1904 and 1916 awakened interest in the subject and active work began with the passing of the South Dakota anti-barberry law in 1917. The present campaign for barberry eradication was begun in April 1918. A preliminary campaign of education and survey was organized, and the field work was begun about April of that year. Congress appropriated in 1918, $150,000 for barberry eradication. Since that time eradication has been conducted in cooperation with each of the following 13 states: Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming. A federal quarantine was placed, effective May 1, 1919, prohibiting the movement into the eradication area of any barberries known to harbor the black stem rust of wheat and other grains. A much larger appropriation of $350,000 became available July 1, 1922, under which marked progress has been made during the field season of 1922. During the five years, 1918–1922, practically all cities and villages of the 12 states have been covered once and resurveyed in part, and 472 counties have been completely covered. This includes 39 counties surveyed on funds furnished by states. In the 5 years, 2,069,017 bushes have been found in cities and villages and 3,740,351 on farms, making a grand total of 5,829,368 bushes found, of which 5,173,547 have been removed.

Roy G. Pierce, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The National Geographic Society announces a series of Contributed Technical Papers embodying the scientific results of its expeditions. The first number entitled "*The origin and mode of emplacement of the great tuff deposit of the Valley of Ten Thousand Smokes,*" by C. N. Fenner of the Geophysical Laboratory, which cooperated with the Geographic Society in the Katmai Expedition, is now ready.

Dr. Fenner's paper gives details of the hot sandflow not included in the nontechnical volume, "*The Valley of Ten Thousand Smokes,*" by the director of the expedition, Robert F. Griggs, recently published by the National Geographic Society.

This series of papers from time to time will embody researches in diverse fields of science resulting from National Geographic Society expeditions. Notices of their appearance will be sent to all who desire such notification. The papers themselves will be distributed only to those who specificially request them.

The Board of Managers of the Washington Academy of Sciences has elected the following scientists to honorary foreign membership in recognition of their prominence in their respective fields and their intimate connection with scientific work in Washington:

Professor LEON MANOUVRIER, Ecole d'Anthropologie, Paris, France, was elected in recognition of his life-long work of the highest class in anthropology.

Dr. CARL FREDERIK ALBERT CHRISTENSEN, Director of Universitetets Botaniske Museum, Copenhagen, Denmark, was elected in recognition of his services to systematic botany, particularly his monographic studies of tropical American ferns of the tribe Dryopterideae.

Dr. PAUL MARCHAL, Chef de Section, Service des Epiphyties, Ministry of Agriculture of France, was elected in recognition of his investigations in biological problems and their relation to agriculture, and especially for his research work in polyembryony.

Mr. EDWARD CLAYTON ANDREWS, Government Geologist of New South Wales, Sydney, Australia, was recommended in recognition of his distinguished work in geology, particularly in the fields of origin of coral reefs, physiography, origin of the Australian flora, mountain formation, and origin of metalliferous deposits.

Sir ERNEST RUTHERFORD, Director of the Cavendish Laboratory, University of Cambridge, England, was elected in recognition of his distinguished work in chemistry.

F. OMORI, Professor of Seismology, Imperial University, Tokyo, Japan, was elected in recognition of his outstanding work in the field of Seismology.

Professor GUISEPPI STEFANINI, Instituto di Studi Superiori, Pizza San Marco, Florence, Italy, was elected in recognition of his distinguished investigations in paleontology and stratigraphy, especially the tertiary formations of Italy and echinoids in general.

Professor MAX WEBER, University of Amsterdam, Amsterdam, Netherlands, was elected in recognition of his distinguished work in zoology.

The Biological Survey, U. S. Department of Agriculture, has arranged with the Navy Department for transportation for a party of scientists who will make a general survey during the spring and summer of the plant and animal life on the chain of islands extending from Niihau in the Hawaiian group to Midway and Wake. Dr. ALEXANDER WETMORE of the Biological Survey will have general direction of the scientific activities of the expedition, which will be carried on in part by members of the staff of the Bishop Museum, Honolulu. DONALD R. DICKEY of Pasadena will accompany the party to secure moving pictures of the remarkable colonies of sea birds on Laysan Island.

The speaker at the meetings of the Physics Club, Bureau of Standards, on March 19 and 26 was Dr. C. W. KANOLT, his subject being *Relativity*.

In the first lecture the older or special theory was considered. This was developed by Einstein mainly as a result of the failure of the experiments of Michelson, Morley, and Miller to detect a motion of the earth relative to the ether. Einstein postulated the independence of phenomena in a system moving with uniform velocity of the velocity of the system, provided the phenomena are observed from within the system. He postulated that the velocity of light is constant under all conditions, which means that it must be the same in all directions, independent of the velocity of the source and independent of extraneous influences, including gravitation. He also assumed tacitly the accuracy of Euclidean geometry. Some of the deductions from this older theory were described.

In the second lecture it was explained that the older theory did not agree with Newton's law of gravitation, and that to harmonize the two and also to extend the conception of the relativity of space and time Einstein had

developed a general theory of relativity, in which he abandoned the assumption that the velocity of light is independent of gravitation, abandoned Euclidean geometry but employed the more general geometrical ideas of Riemann, and introduced the hypothesis of the equivalence of a uniform gravitational field and a uniform acceleration of suitable magnitude. From this point of view the older theory is applicable only when gravitational forces are negligible. The consequences of the general theory relative to the perihelial motion of Mercury, the influence of the sun's gravitational field upon the paths of light beams from the stars and upon the wave length of spectral lines from the sun were discussed.

Dr. WALTER ROSENHAIN of the National Physical Laboratory, Teddington, England, spoke at the Bureau of Standards on Monday, April 2, on *The work of the National Physical Laboratory.*

An experimental test of Einstein's principle of equivalence was discussed by Dr. P. R. HEYL at the April 9th meeting of the Bureau of Standards Physics Club.

Miss ALICE C. FLETCHER died on Friday, April 6, in Washington, D. C., in her 79th year. She was born in Boston, Massachusetts, March 15, 1845. Her life was devoted to work among the American Indians, and she made numerous contributions to the literature of ethnology, her book, *Indian story and song from North America*, being her best known publication. For many years Miss Fletcher was assistant ethnologist at the Peabody Museum,and held the Thaw fellowship since 1891. She was a member of the ACADEMY and the following local scientific societies: Anthropological (President, 1893), Archeological, and Historical, as well as a number of national organizations.

Dr. AUGUST HUND has been appointed electrical engineer, Radio Section, Bureau of Standards. He is a graduate of the Technische Hochschule, Karlsruhe, and took the degree of Doctor of Engineering in 1913. He was with the General Electric Company under Dr. Steinmetz from 1915–1917, and has been doing graduate work at the University of California since that time. Dr. Hund has written a book on the technique of high frequency measurements.

THE APPARATUS CONFERENCE

A Conference of Makers and Users of Scientific Apparatus was held at the National Research Council on March 23 and 24. Representatives were present from the American Chemical Society, the American Physical Society, the American Institute of Electrical Engineers, the American Electrochemical Society, and the Optical Society of America. The Scientific Apparatus Manufacturers' Association and the Manufacturing Chemists' Association, as well as several manufacturers of apparatus and supplies, sent representatives. The universities were represented by the Association of Educational Buyers, and the Federal Government, by members of the Bureau of Standards, Bureau of Chemistry, Geological Survey, and other bureaus. Members of the Carnegie Institution and of the National Research Council were also in attendance. G. K. BURGESS of the Bureau of Standards presided.

The question of "Apparatus Supply" was covered by papers on *Importation* by Mr. EIMER of the firm of Eimer and Amend; *Domestic apparatus manufacture* by Mr. LEEDS of the Leeds and Northrup Company and Pro-

fessor RICHTMYER of Cornell University; *The Instrument shop of the research and college laboratory* by Mr. COLLINS of the Geological Survey; and *The Manufacture of special apparatus not now made in the United States* by Mr. IVES of the Western Electric Company.

The subject of "Standardization of Apparatus" was covered by papers on *Limitation of types and sizes* by Secretary ROBERTS of the Apparatus Manufacturers' Association; *Standardization of parts* by Mr. DICKINSON of the Society of Automotive Engineers; and *Standardization of methods* by Mr. BURGESS.

There were also papers on *Sources of information* by Mr. EARNSHAW of the Buyers' Association; *Finding list* by Mr. TISDALE of the Research Council; *Scientific Bulletins concerning apparatus and its use* by Mr. LEEDS; and *Inspection service* by Mr. WASHBURN of the Research Council.

There was active discussion of all of these papers. A permanent form of organization was adopted, consisting of a large committee or conference representing societies, institutions, and manufacturers, with a small executive committee elected by the conference. The members of the executive committee are: W. M. CORSE, Chairman, PAUL MOORE, Secretary, G. K. BURGESS, W. D. COLLINS, M. E. LEEDS, F. K. RICHTMYER, and JOHN ROBERTS.

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MATHEMATICS.—*The reduction of all physical dimensions to those of space and time.* A. P. Mathews,[1] University of Cincinnati.

To reduce the number of different kinds of things has been the general course of development of science. Thus in chemistry the diverse substances on the earth's surface have been found to be composed of about 100 simpler substances or elements; and these elements, in their turn, of different numbers of positive and negative electrons. Similarly the forms of radiant energy—heat, light, X-rays, electromagnetic waves—have all been reduced to one kind differing only in size. So also in the case of those other entities with which physics deals—electricity, magnetism, force, energy, matter, heat—increase of knowledge has enabled a considerable simplification accompanied by a clarification of ideas.

The end of this movement must be to express the physical entities of the universe in the terms of the four dimensions, three of space and that of time. With these four dimensions we should then be able to write the whole of the physical universe in the equations of a four dimensional space.

There is, to be sure, a fifth dimension, which we must at present conserve, namely, the unknown dimensions of psychism. By psychism I mean that property of matter, at present neglected by the physicist, which is exhibited in its clearest form in living things and which shows itself in thought and consciousness in such large psychic units as ourselves. The course of evolution of living beings has been such as to create larger and more perfect psychic units. We might formulate the general law that the course of evolution was in the direction of increase of psychism. If we put P for the undetermined dimensions of psychism,—the unknown, and usually unrecognized, psychic factor

[1] Received, April 12, 1923.

in all matter and energy—the five dimensions in which the universe as at present known to us could then be described would be $(L_1) \times (L_2) \times (L_3) \times (T) \times (P)$. It may be possible in the future to write (P) in terms of space and time. Indeed it may possibly be nothing else than time, since, as has been generally recognized, time has a definite psychical element in it.

Leaving the dimensions of P at one side, the object of the present paper is to show how all the physical phenomena of the world may be expressed in dimensions of space and time to the great simplification and clarification of many conceptions.

Several attempts to do this have been made already with more or less success. Sir Oliver Lodge,[2] for example, has pointed out that the

[2] Lodge: Modern Views of Electricity, 1889, Macmillan & Co. Appendix, page 402. "Comparing many electrical equations with corresponding mechanical ones we find that the product LC (L being length and C current) takes the place of momentum(mv) and that 1/2 LC^2 takes the place of kinetic energy (1/2 mv^2) and indeed is the energy of a current. Hence it is natural to think of L as involving inertia and of μ and $4\pi\,\mu$ as a kind of density of the medium concerned. Assuming this $4\,\pi/K$ at once becomes an elasticity coefficient (as indeed electrostatics suggests) because $\mu K v^2 \equiv 1$; and the dimensions of all electrical units can be specified as follows, without any arbitrary convention or distinction between electrostatic and electromagnetic units.

$$\text{Sp. ind. cap., } K = \frac{\text{strain}}{\text{stress}} = \frac{\text{area}}{\text{force}} = \frac{LT^2}{M} = \text{shearability}$$

$$\mu = \frac{\text{inertia}}{\text{volume}} = \frac{M}{L^3} = \text{density}$$

$$\text{Electric charge} = L^2 = \frac{\text{volume}}{\text{displacement}}$$

$$\text{Magnetic pole} = \frac{M}{T} = \text{momentum per unit length}$$

$$\text{Electric current} = \frac{L^2}{T} = \text{displacement} \times \text{velocity}$$

$$\text{Magnetic moment} = \frac{ML}{T} = \text{momentum}$$

$$\text{E. M. F.} = \frac{\text{work}}{Q} = \frac{M}{T^2} = \text{pressure} \times \text{displacement, or work per unit area}$$

$$\text{Intensity of magnetic field, } H = \frac{F}{m} = \frac{L}{T} = \text{velocity}$$

$$\text{Intensity of electrostatic field, } \frac{F}{Q} = \frac{M}{LT^2} = \text{energy per unit volume}$$

Surface density = a pure number

$$\text{Electric tension} = \frac{M}{LT^2} = \text{a pressure or tension}$$

dimensions of (e), quantity of electricity, may be (L^2). Lewis and Adams[3] in the manner of the relativists reduced space and time to one dimension, an interval, I; but kept mass, M, as a dimension. They thus equate time with length. On this basis and disregarding specific inductive capacity which now, with velocity, has no dimensions, they attempt to explain several exact numerical agreements they have found between various constants. These agreements will be considered in a later paper.

In all these attempts to reduce the number of dimensions, mass has been the principal stumbling block. The discovery of the electrical constitution of matter enables us, however, to write mass in terms of electricity and self induction and reduce it to the dimensions of space, or (L^3). Fournier d'Albe[4] has already shown how the dimensions of magnetism may be written in those of electricity, but he still keeps electric quantity, or (e), as a fundamental unit along with mass. His identification of magnetism with electricity in motion, however, practically involves the conclusion that magnetic permeability, μ, which is generally considered to be a density, has no dimensions, and that accordingly mass and space are identical.

Since electricity appears to be the most fundamental quantity of all, the first step is to reduce it to the dimensions of L^2.

I. THE DIMENSIONS OF QUANTITY OF ELECTRICITY, (e)

Matter is composed of electrical charges, the atoms being essentially electrical doublets; positively charged nuclei or spheres, accompanied by an equal quantity of negative electricity, negative electrons.

By matter we express three fundamental concepts, namely space, weight and inertia. Matter is that which occupies space, and possesses

Capacity, $S = \frac{Q}{E} = \frac{L^2T^2}{M}$ = displacement per unit pressure

Coefficient of resistance $= \frac{E}{C} = \frac{M}{L^3T}$ = impulse or momentum per unit volume

Magnetomotive force $= 4\ nC = \frac{L^2}{T}$ = current

Reluctance $= 1/\mu A = L^2/M$ = area/inertia

Magnetic induction, $I = M/T$ = moment of momentum per unit area

Coefficient of induction (self or mutual) $1/C = M/L^2$ = inertia per unit area

[3] Lewis and Adams: A Theory of Ultimate Rational Units; numerical relations between elementary charge, Wirkungs quantum, constant of Stefans Law. Physical Review, 1914, Ser. 2, III, p. 92.

inertia and weight. Matter or mass has three spatial dimensions and it is from it that we get our conception of 3 dimensional space. The recognition that matter consists of electric charges carries with it the consequence that inertia is self induction. For to move electrical charges, or to change their rate of motion, work, positive or negative, must be done. Inertia is hence nothing but self induction. Every time an object is moved a myriad of parallel electric currents are produced. The self induction, or inertia, is due presumably to the production of a stress, strain or twist in the ether. This ether stress, flux or twist per second is what is known as energy.

Mass is then proportional to quantity of electricity and self induction.

(1) Mass = Quantity of electricity $\times$ self-induction.

(2) $M = (e) \times I$

Substituting the dimensions for these quantities:

$$(3) \qquad (M) = (M^{1/2}L^{3/2}T^{-1}K^{1/2} \times L\,\mu)$$

and since
$$\mu^{1/2}K^{1/2} = \frac{T}{L}$$

$$(4) \qquad (M) = \left(M^{1/2}L^{3/2}T^{-1} \times \frac{T}{L} \times L\mu^{1/2}\right) = (M^{1/2}L^{3/2}\mu^{1/2})$$

$$(5) \qquad \therefore (M) = (L^3\mu)$$

$$(6) \qquad (\mu) = \left(\frac{M}{L^3}\right)$$

In other words μ, magnetic permeability, has the dimensions of a density as recognized by Maxwell, Lodge and Williams.

$$(7) \qquad \text{Since } (\mu K) = \frac{T^2}{L^2}$$

$$(8) \qquad \therefore (K) = \left(\frac{LT^2}{M}\right) = \text{specific inductive capacity}$$

Substituting this value of K in the dimensions of (e)

$$(9) \qquad (e) = (M^{1/2}L^{3/2}T^{-1}K^{1/2}) = \left(M^{1/2}L^{3/2}T^{-1}\frac{L^{1/2}T}{M^{1/2}}\right) = (L^2)$$

Quantity of electricity, or (e), has therefore the dimensions of L^2, as already pointed out as a possibility by Lodge.[2]

II. THE DIMENSIONS OF MAGNETISM OR MAGNETIC FLUX

The electrical theory of magnetism shows that this is nothing else than the phenomenon of electricity in motion. The quantity of it, that is (M′), or magnetic flux, is determined by, or is nothing else than, the quantity of electricity multiplied by its velocity. Hence the dimensions of magnetic flux (M′)

(10) $$(M') = (e) \times (v) = \left(L^2 \times \frac{L}{T}\right)$$

(11) $$\therefore (M') = \frac{L^3}{T}$$

Magnetism is space per second; or it is electric quantity × velocity; or it is electric current, $\left(\frac{L^2}{T}\right)$, times a length; or it is current, $\left(\frac{L^2}{T}\right) \times$ inductance (L); or mass × a frequency.

III. THE DIMENSIONS OF MASS

The dimensions of mass may be obtained from those of magnetism.

(12) $$(M') = (M^{1/2}L^{3/2}T^{-1}\mu^{1/2})$$

Substituting for μ its dimension $\frac{M}{L^3}$ in (6)

(13) $$(M') = \left(M^{1/2}L^{3/2}T^{-1}\frac{M^{1/2}}{L^{3/2}}\right) = \left(\frac{M}{T}\right)$$

That is magnetism is mass per second. Or in another way, mass, (M), is nothing else than magnetic flux-seconds. But as shown in (11) magnetic flux is the product of electric quantity by velocity, or $(M') = \left(\frac{L^3}{T}\right)$. Hence:

(14) $$\left(\frac{L^3}{T}\right) = \left(\frac{M}{T}\right)$$

(15) $$\therefore (M) = (L^3)$$

Mass, therefore, has three dimensions of space. This follows also from the dimensions of μ, magnetic permeability. This, as has been shown, is a density, or $\left(\frac{M}{L^3}\right)$, and it is usually identified with the density of the ether (Maxwell, Lodge, Tunzelman, etc.). Since the ether is

incompressible, its density is everywhere the same. Consequently mass may be identified with volume of ether. It has the dimensions of space. This is in accordance with the conclusions of Fournier d'Albe[4] who gives μ no dimensions and also with the identification of matter with space by Descartes. Since mass is magnetic flux-seconds, its relation to the quantum constant, h, which is ergs-seconds, is apparent at once, and this will be taken up later. Since mass is magnetic flux-seconds and magnetic flux is quantity of electricity $\times$ velocity, mass is current $\times$ inductance $\times$ time, or it is, as specified at the outset, proportional to quantity of electricity $\times$ inductance.

The derivation of the dimensions of mass can also be made from energy in the following way:

Energy consists of the product of two factors: a quantity factor, and an intensity factor. The total work it is capable of doing depends on these two factors. Whether any interchange of energy occurs between two systems depends always on the intensity factor, not on the quantity factor. The quantity factor of energy always has the dimensions of mass, (M); the intensity factor has the dimensions of L^2/T^2, that is the dimensions of the square of a velocity, or an elasticity. For example, the total energy in a waterfall is measured by the quantity of water available multiplied by the height of the fall and the acceleration due to gravity. The intensity factor is hence height, or (L), times an acceleration or (L/T^2) and this is equal to (L^2/T^2). These dimensions must be the same for the intensity factor of every form of energy; and from them the dimensions of mass may be obtained. For example, volume energy as it may be called, i.e., the total kinetic energy of the molecules of a gas, is proportional to the product of the pressure per square centimeter multiplied into the volume. The intensity factor here is the pressure per square centimeter, which decides whether energy will flow from one to another of two containers put into communication. The intensity factor is hence $F/L^2 = M/LT^2$. But this is equal to L^2/T^2. Hence $(M) = (L^3)$. Similarly the quantity factor in the case cited is the volume, (L^3), and this is necessarily equal to (M). Similarly the intensity factor of free energy, the energy of radiation for instance, is the density of the energy, or the energy per cc., $ML^2/L^3T^2 = M/LT^2 = L^2/T^2$. Hence again $M = L^3$. Temperature is often called the intensity factor of heat energy, but this is incorrect if temperature be identified with the kinetic energy of the molecules. The temperature of a molecule is its kinetic energy. The

[4] Fournier: The Electron Theory. Longmans, Green & Co. 1906.

intensity factor, however, is again the pressure this molecule can exert per square centimeter, or M/LT^2, and this being equal to L^2/T^2, $M = L^3$. The intensity of an electrostatic field is M/LT^2; from whence again $M = L^3$.

Hence since everywhere intensity of energy has the same dimensions, L^2/T^2, the dimensions of mass are found to be L^3, just as they were found from the electrical constitution of matter.

The great gain made in reducing mass and electric quantity to the dimensions of (L^3) and (L^2) respectively will be apparent. If we keep mass and electricity fundamental dimensions, (M) and (E), as Fournier does, there is no indication of any relation between them or of their real meaning. But if we write mass as (L^3), it is clear at once that it represents space or volume, that it consists of three components, and in addition that it contains electric quantity, or (L^2) and a length or self induction, (L). The relation between mass and electricity is seen at once. Similarly, writing electricity as (e), exhibits nothing of its qualities, whereas (L^2) makes it a surface phenomenon, and relates it at once to its peculiarity of accumulating on surfaces and to its surface density. The relations between quantity of magnetism $\left(\frac{L^3}{T}\right)$ electricity (L^2), and mass (L^3), are clear by simple inspection. For example, magnetic flux is (L^3/T), while electric current is (L^2/T). This shows at once that magnetic flux is the product of current by its length. And electric quantity or, L^2, is magnetic flux $\times$ (T/L). That is, it is magnetic flux times the square root of K, the specific inductive capacity. The specific inductive capacity has the dimensions of the ratio of electric quantity to quantity of magnetic flux. The results of considering T equivalent to L_4 are considered on page 206.

IV. THE DIMENSIONS OF THE ETHERIAL CONSTANTS

Since μ, magnetic permeability, $= \frac{M}{L^3} = \frac{L^3}{L_3} = 1$ and so has no dimensions, and $(\mu\ K) = \left(\frac{T^2}{L^2}\right)$, K being the specific inductive capacity:

$$\therefore (K) = \left(\frac{T^2}{L^2}\right) \tag{16}$$

These are the dimensions already ascribed to K by Fournier d'Albe. And as he has pointed out, all the phenomena of refraction and disper-

sion are readily comprehended if K has these dimensions. In other words, K is inversely as current × a frequency; or inversely as electric quantity × angular acceleration; or it is inversely as the square of a velocity, the velocity being the velocity of long etherial waves in the medium.

All of these have a meaning. For example K being inversely as electric quantity×angular acceleration would mean that K was directly proportional to the square of the number of electrons per cc. $= \frac{1}{L^2}$ and $1 \div$ angular acceleration might be the "laxity" of the electrons. Also as $\frac{L^2}{T^2}$ is elasticity, K is inversely as an elasticity.

While the numerical value of μ is very nearly unity, except in paramagnetic and ferromagnetic substances, K varies from unity to 80 in dielectrics and to infinity in perfect conductors in which electromagnetic waves will be stopped.

The other great etherial constant is that of *gravitational permeability*, G. The numerical value of this constant for all known substances is so near unity that the constant itself is usually omitted from the formulas of gravitational attraction. And accordingly it is usually assumed that the gravitational attraction of two masses does not depend on the medium. This, however, must be an incorrect assumption if electromagnetic mass is also gravitational, as is probable. Electromagnetic or electrostatic attractions involve the medium, and as matter is nothing but electrical charges its mutual attraction must so depend also.

The Newtonian law of attraction shows this necessity also.

The following reasoning equally indicates this.

While electric quantity, or (e), is independent of the medium, the force between charges, i.e., the attraction or repulsion of two charges, depends upon the medium. It depends on the specific inductive capacity, or K. Similarly while quantity of magnetism, or magnetic flux, that is electricity in motion, does not depend on the medium, the force between two poles or two currents does so depend. It involves μ, the magnetic permeability. Just so in the case of mass. While the quantity of mass is independent of the medium, the force between two masses, which is called gravitation, or weight, must depend on the medium. This is a necessary consequence of the electrical constitution of matter. Gravitation must involve a quality of the medium which we may call the gravitational permeability and designate by G.

This may be expected to involve both the specific inductive capacity and magnetic permeability. To get its dimensions we have to turn to the Newtonian law of gravitation.

$$F = \frac{M\ M'\ g}{d^2} \tag{17}$$

Equation (17), which states that the force of attraction is directly as the product of the masses and inversely as the square of the distance, leaves out the gravitational permeability and accordingly does not balance dimensionally. The equation is ordinarily made to balance dimensionally by arbitrarily ascribing to g, the dimensions $\frac{L^3}{MT^2}$.[5] But this is incorrect, for g is a numerical constant without dimensions, having the value of 6.66×10^{-8} and is in the equation because the unit of mass has been arbitrarily chosen as that of 1 cc. of water at a certain temperature. Had unit mass been defined as that mass exerting unit force on another similar mass at unit distance, g, would have had the value of unity and would not have been in. It is clear that the factor G, gravitational permeability, must be put into the denominator. Hence the equation would be:

$$F = \frac{M\ M'\ g}{G\ d^2} \tag{18}$$

and G will have the dimensions

$$(G) = \left(\frac{M\ T^2}{L^3}\right) = (\mu T^2) = eK\mu = L^2 \times \frac{T^2}{L^2} = T^2 \tag{19}$$

That is, gravitational permeability is equal to magnetic permeability $\times$ specific inductive capacity $\times$ electric quantity or area. Its final dimension is (T^2), which is either the square of a period, or the reciprocal of angular acceleration. The value of G will probably be unity for all substances except possibly hydrogen, for hydrogen alone is exceptional in its atomic weight. All other elements have atomic weights which are whole numbers, the weight of oxygen being taken as 16. Hydrogen alone has an atomic weight which is not a whole number. Its atom instead of a weight of 1, is 1.008. It is not probable that this is due to the presence of isotopes. It may be attributed to the fact that the gravitational permeability of hydrogen is less than unity and probably in the proportion $\left(\frac{1}{1.008}\right)^2$. Harkins has ascribed the difference

[5] See for example Planck. Heat Radiation p. 174–175. (Translation by Masius.)

between the weight of hydrogen when free and hydrogen as a constituent of other elements to a "packing effect," but it is possibly more natural to ascribe it to a variation in gravitational permeability.

V. THE NATURE OF ENERGY

The foregoing reduction of physical quantities to space and time makes clear the nature of energy, which has been so difficult a conception to grasp.

$$(20) \qquad (E) = \text{energy} = \left(M \times \frac{L^2}{T^2}\right);$$

but since $M = L^3$

$$(21) \quad (E) = \left(\frac{L^5}{T^2}\right) = \left(\frac{L^3}{T} \times L^2 \times \frac{1}{T}\right) = \text{magnetic flux} \times \text{electric quantity per second.}$$

In other words all energy, of whatever kind, potential or kinetic, is the product of magnetic flux and electric current, or magnetic flux times electric quantity per second or of magnetic flux times electric quantity × a frequency. This magnetic flux may be identified, as is usual, with ether flow (that is electric quantity × velocity), and electric quantity with ether twist. Hence all energy is in the ether and is nothing else than a certain quantity of twisted etherial flow or strain.

That potential energy is nothing else than some kind of strain in the ether, the latter being perfectly elastic, is generally supposed. So all the energy of position whether this be gravitational energy, as in the separation of masses; electrostatic, as in the separation of charges; chemical, as in the separation of atoms; cohesional, as in the separation of molecules; or magnetic, as in the separation of magnetic poles or currents, is nothing else than a strain, twist or what not in the ether. It is an etherial phenomenon. It is always and everywhere magnetic flux × electric quantity × frequency. Similarly with kinetic energy; for kinetic energy is the expression of inertia and elasticity. Inertia is self induction. To move an electric charge from rest, or to increase its velocity when in motion, strain in the ether is set up or increased just as in separating unlike charges to make potential energy. The greater the velocity, and the greater the mass, i.e., the greater the number of electric charges moved, the greater is this strain. When a moving body or current stops, or is retarded, this strain or energy or deformation is suddenly released. Consequently all energy whether

kinetic or potential is etherial strain. And quantity of energy is quantity of etherial distortion per second.

Now both magnetic flux and electric quantity are often particulate. Magnetic flux $\times$ length is so many magnetons; electric quantity, so many electrons. An electron is the smallest possible amount of electricity which can exist independently; and a magneton is possibly the smallest amount of magnetic moment. Hence energy which is nothing more than the quantity of magnetic flux and electric quantity formed in the ether per second by moving particulate electric charges may also be supposed to be particulate. It must be in multiples of "kinetons." And we may identify one "kineton" with one quantum or several quanta of energy.

The quantum constant h has the dimensions of ergs-seconds. It is, therefore, nothing else than a definite amount of magnetic flux $\times$ electric quantity.

$$(22) \qquad (h) = \text{ergs-seconds} = \frac{L^5}{T^2} \times T = \left(\frac{L^5}{T}\right) = \left(\frac{L^3}{T} \times L^2\right)$$

Hence h is related to mass. Mass is magnetic flux seconds and h is ergs-seconds—that is, it is magnetic flux $\times$ electric current seconds.

Temperature, θ, has the dimensions of energy. It too is (L^5/T^2), or magnetic flux $\times$ electric charge per second. Temperature is nothing else than the product of magnetism by current. This is obvious whether we are dealing with temperature of a material body which is the kinetic energy of its molecules and atoms, or the temperature of the ether, radiant heat, which is nothing else than an electro-magnetic disturbance in the ether; i.e., a certain quantity of free magnetism $\times$ electric current; or latent heat which is potential energy.

This conception that all energy, of all kinds, whether potential or kinetic, is nothing else than a certain quantity of magnetic flux multiplied by a certain quantity of electric current in the luminiferous ether, the writer has found to be extremely useful in simplifying his conceptions. It is of course an old conception and one which should be revivified. But if magnetic flux is nothing but a phenomenon of electricity in motion, energy may be represented as $\frac{L^5}{T^2} = \frac{L^2}{T} \times \frac{L^2}{T} \times L$. That is, energy is the product of the square of electric current in the ether, multiplied by self induction, or by a length; or it is the square of electric quantity multiplied by acceleration $L^2 \times L^2 \times \frac{L}{T^2}$.

Of these conceptions the most useful appears to the writer to identify magnetic flux with etherial flow, and electric charge with a twist, as is usual.

Having identified the quantum constant, h, with the product of a certain quantity of magnetic flux by electric quantity which when multipled by a frequency gives energy, one is tempted to go farther and identify h, *with the total minimum quantity of magnetic flux × electric quantity in a wave front.* This quantity is the same in every wave, whatever its period, which is set up by one electron. If this quantity is multiplied by the number of such waves per second, we have energy, that is the amount of magnetic flux times electric quantity per second radiated by that electron.

Energy is radiated in quanta since no energy is radiated until an amount of magnetic flux and electric quantity equal to that contained in a wave front due to one electron is reached. This quantity of strain must be accumulated before radiation can occur. A wave or pulse is then set travelling through the ether. It is as if a slip occurred when this quantity accumulated. Since the wave front contains mass, (L^3), or magnetic flux multiplied by time, the waves will exert pressure, and will be attracted gravitationally.

The relations of the numerical value of h, to other constants of nature will be considered in a following paper.

Since energy radiated is *hn*, depending only on frequency, it would seem to follow that the amplitude of every wave from a single electron must be the same at its origin. An electron accelerated by the absorption of energy cannot change its amplitude of radiation. All that happens by the acceleration is an increase in frequency, a shifting in other words toward the shorter waves. It is an interesting question what this fundamental amplitude is. An increase in amplitude could then only be brought about by the fusion of waves; by an increase in the number of oscillators, in other words.

For convenience table 1 gives the dimensions of all entities in those of space and time.

VI. THE DIMENSIONS OF ALL NATURAL PHYSICAL PHENOMENA IF TIME IS A FOURTH SPATIAL COORDINATE, L_4

In the simple way just stated we have reduced the dimensions of all physical phenomena to those of space, (L_1, L_2, L_3) and time, (T). If now, time be considered a 4th spatial coordinate and equated with L, being written L_4, and if we consider this four dimensional space to be isotropic, so that all four directions are equivalent, as is done in

TABLE 1

Time	T	Elasticity $ML^{-1}T^{-2}$	$\frac{L^2}{T^2}$
Period	T	Surface density $\frac{E}{L^2} = \frac{L^2}{L^2} =$	1
Frequency	$\frac{1}{T}$	Current	$\frac{L^2}{T}$
Angular velocity	$\frac{1}{T}$	Electric repulsion (force between charges)	$\frac{L^4}{T^2}$
Angular acceleration	$\frac{1}{T^2}$	Gravitation attraction, $M^2L^{-2}G^{-1} =$ (force between masses)	$\frac{L^4}{T^2}$
Gravitational permeability	$G = T^2$	Magnetic attraction M'^2L^{-2} = (force between poles) (force between circuits)	$\frac{L^4}{T^2}$
Length	L	Electric field	$\frac{L^2}{T^2}$
Area	L^2	Potential	
Electric quantity (e)	L^2	Coefficient of self induction	L
Velocity	$\frac{L}{T}$	Magnetic Pole	$\frac{L^3}{T}$
Acceleration	$\frac{L}{T^2}$	Magnetic Moment	$\frac{L^4}{T}$
Mass, m,	L^3	E. M. F. =	$\frac{L^3}{T^2}$
Magnetic flux, M′,	$\frac{L^3}{T}$	Intensity of magnetic field	$\frac{L}{T}$
Force, MLT^{-2}	$\frac{L^4}{T^2}$	Intensity of electrostatic field	$\frac{L^2}{T^2}$
Moment MLT^{-2}	$\frac{L^4}{T^2}$	Surface density	= a pure number
Work ML^2T^{-2}	$\frac{L^5}{T^2}$	Capacity	$\frac{T^2}{L}$
Energy ML^2T^{-2}	$\frac{L^5}{L^2}$	Coefficient of resistance	$\frac{1}{T}$
Heat, Θ	$\frac{L^5}{T^2}$	Magnetomotive force	$\frac{L^2}{T}$
Power	$\frac{L^5}{T^3}$	Reluctance	$\frac{1}{L}$
Density $\frac{M}{L^3}$	1	Magnetic induction	$\frac{L^3}{T}$
Pressure per sq. cm. $ML^{-1}T^{-2}$	$\frac{L^2}{T^2}$		
K, sp. ind. cap.	$\frac{T^2}{L^2}$		
μ = magnetic permeability	1		
Moment of inertia, ML^2	L^5		

relativity, then various interesting results follow, and these may now be briefly considered. This enables us to write all dimensions as L or its powers. In table 2 the dimensions of all entities are given in terms of L.

TABLE 2

Moment of inertia	L^5
Ergs-seconds	L^4
Mass	L^3
Energy	L^3
Work	L^3
Temperature	L^3
Magnetic moment	L^3
Volume	L^3
Electric quantity	L^2
Magnetic pole	L^2
Magnetic flux	L^2
Magnetic induction	L^2
Area	L^2
Force	L^2
Moment	L^2
Power	L^2
Gravitational permeability	L^2
Angular acceleration	$\frac{1}{L^2}$
Time	L
Period	L
Length	L
Current	L
Coefficient of self induction	L
Electromotive force	L
Capacity	L
Magnetomotive force	L
Acceleration	$\frac{1}{L}$
Angular velocity	$\frac{1}{L}$
Frequency	$\frac{1}{L}$
Coefficient of resistance	$\frac{1}{L}$
Reluctance	$\frac{1}{L}$
Without dimensions $\left(=\frac{L}{L} \text{ or } \frac{L^2}{L^2} \text{ or } \frac{L^3}{L^3}\right)$:	
Magnetic permeability	
Dielectric constant	
Velocity	
Elasticity	
Intensity of electrostatic field	
Intensity of magnetic field	
Constants of nature:	
a (black radiation density)	$\frac{1}{L^2}$
c_2 (cm. degrees)	L^4
h (ergs-seconds)	L^4
c (cms. per second)	1
$\frac{e}{m_e}$ (charge to mass)	$\frac{1}{L}$
k_2 (ergs/degrees)	1
n (Rydberg frequency)	$\frac{1}{L}$
m_e (mass of electron)	L^3
m_H (mass of H atom)	L^3
e (electron charge)	L^2

It will be observed that magnetic quantity $\frac{L^3}{T}$ now becomes L^2, and has the dimensions of electrical quantity, (e). Both are L^2. And this is the same as the dimensions of force and also of gravitational permeability. Now the only way we recognize magnetism or electricity is by the force it exerts on charged bodies. It is, therefore, extremely interesting that all three are nothing but force, L^2. Magnetic induction and magnetic pole are also L^2.

Furthermore electric charge being (L^2), shows that it cannot be simple, but must be constituted by the product of two coordinates (L_1) and (L_2). It is an interesting question what these two coordinates are and whether electric quantity, or e, is in reality (L^2), or (L^2), or (L_1) (L_2). It should be possible in the latter case to make an electron charge either by an increase in L_1 with less L_2, or vice versa. Just as mass can be formed by much L^2 and little L_1, or by a smaller amount of electricity and a greater inductance. That is, we may have the same quantity of mass by moving a large number of electrons slowly; or a smaller number with greater velocity. Similarly, e may be formed by moving a long distance along L_1 and a small distance along L_2, or a small interval along L_1 and a large interval along L_2, or by equal intervals of both. The square root of e in e. s. u. is 2.185×10^{-5} units of interval or L.

Mass, energy, and moment of magnetism now all have the same dimensions. They may be identified as equivalent, provided the various spatial coordinates are equivalent, but not if they are not. Each has the dimensions of L^3. Again it is obvious that each of these three has in it electric quantity, L^2, and self inductance, L. Furthermore if these various coordinates are not the same, we can obtain the same quantity of mass or energy or magnetic moment by changes in velocity or in any of the three intervals.

Velocity, elasticity, specific inductive capacity, magnetic permeability, intensity of magnetic field, intensity of electrostatic field, are now without dimensions. They are but the ratio of two intervals L_x/L_y.

Acceleration, angular velocity, frequency, coefficient of resistance and reluctance all have the dimensions of the reciprocal of an interval, $\frac{1}{L}$.

Time, period, length, current, coefficient of self induction, electromotive force, capacity, magnetomotive force, all have the dimension L.

Moment of inertia is L^5.

The interpretation of these results may be left for each one to make for himself. That they offer an enormous apparent simplification of things is obvious. In relativity the attempt has been made already to identify mass with energy. Eddington[6] for example says "Hence it appears that mass (inertia) and energy are essentially the same thing or at the most two aspects of the same thing."

The foregoing resolution of the dimensions of each to L^3, or space,

[6] Eddington: Space, Time and Gravitation. Cambridge, 1920.

clearly indicates this, provided that space is isotropic or that if, when any one coordinate is selected and named one thing, such as time, or self induction, the others are at once determined by their relation to this. Mass and energy have the dimensions of volume. In the terms of the ether this means that the energy of the ether, like its mass, is everywhere the same.

But if time is kept as a separate entity not to be equated with a length, then energy is more than mass. For energy is magnetic flux $\times$ electric quantity per second, and mass is magnetic flux $\times$ time. And mass is certainly more than inertia since mass is the product of three variables, L_1, L_2, L_3, whereas inductance has but one, L.

The bearing of these results on the numerical relations of the constants of nature will be considered in a following paper.

ERRATUM

Vol. 13, No. 10, May 19, 1923, page 211, third paragraph from top of page, lines 4 and 5: The expression "Type species *H. coronatus* n. sp." should be deleted.

ZOOLOGY.—*An amendation of* Hoplolaimus *Daday, 1905, nec auctores.* N. A. COBB, U. S. Department of Agriculture.

In 1905, Daday proposed the new genus *Hoplolaimus* on the basis of a single female nema from soil in Paraguay; the characterization was necessarily imperfect. Daday could give only the location of the vulva and state his belief that the unseen female organs were double. The mouth parts were such that so experienced an observer as Daday readily concluded he had found a new tylenchoid genus. Hence, *Hoplolaimus*.

Hoplolaimus was so imperfectly characterized that numerous subsequent authors have referred to it a variety of species that seem certain not to belong to it, in the light of recent discoveries now to be described.

Hoplolaimus Daday 1905 amend.

Coarsely annuled typical tylenchidae with a prominently set off, lobed lip-region composed of several annules, and an onchium with more or less lobed basal bulbs. -f- and -m. Males with lobed bursa encompassing the tail. ~~Type species *H. coronatus* n. sp.~~

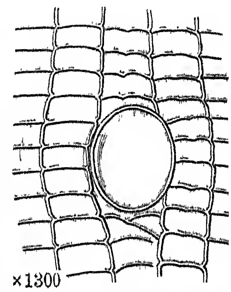

FIG 1. In the left lateral chord (usually) of the male Hoplolaimus at lat. 86, and in the right lateral chord of the female at lat. 32, there is an interesting unpaired spheroidal amphid-like organ, one-fourth as wide as the body, having connections fore and aft, and opening outward on the wing region in the form of a depressed near-circle, 8 microns across. See above.

H. coronatus n. sp. $\frac{3.4}{2.4}\ \frac{7.8}{2.7}\ \frac{12.}{3.}\ \frac{^{25}\ 56.\ ^{26}}{3.3}\ \frac{98.4}{2.4}\ 1.6\,\text{mm}$ The transparent colorless layers of the naked cuticle are traversed by plain, transverse striae, all alike, about three microns apart and easy of resolution, which are not further resolvable, and which are altered materially on the lateral fields by the presence of *three longitudinal wings*, occupying a space, measured midway on the nema, one-third as great as the width of the body. The optical expression of these wings consists of four parallel lines, of which the two outer are rather distinctly crenate, while the two inner, occupying a little less than a third of the wing space, connect with refractive cuticular alterations of the striae, which thus give rise to a rather distinct more or less *quadrangular network* on the lateral fields. On the neck the wings become reduced to two. The cuticle, about two and one-half microns thick, is striated internally as well as externally. As usual, the annules close to the lip region are somewhat narrower than those farther back. From somewhat behind the anus the final striae on the tail of the female make a gradually smaller angle with the lateral line and finally encircle the terminus in the *lateral plane*. Very slightly oblique longitudinal striae, due to the attachment of the musculature, are visible in most regions of the body. There are no dermal appendages and no series of pores has been seen in the cuticle, but there is an unpaired lateral organ on both the female and male. (See Fig. 1.) The cylindroid neck becomes convex-conoid at the rounded head, which is continuous and presents a central mouth opening only very slightly depressed. The lip region however is a flat, bluntish cone, about twenty microns broad by eight microns high; it is set apart by a *very distinct*

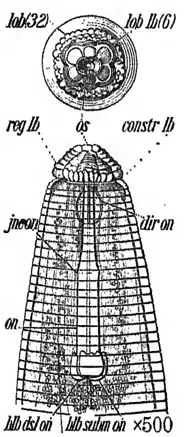

FIG. 2. An obligue dorso-ventral view of head of *H. coronatus* n. sp. The quadrangular nature of the cap is shown in the front view, above.

constriction so that it constitutes a sort of *cap on the front of the head.* This somewhat *quadrate cap is longitudinally faintly six-lobed* and each lobe is again longitudinally as well as transversely subdivided. See Fig. 2. The lip region of the male is like that of the female except that it is more nearly hemispheroid, that is, relatively higher and slightly larger. There is a rather robust six-ribbed, yellowish, dome-like structure as the framework of the lip-region, through it is obscured by the nature of the cuticular covering. This framework extends a little back of the labial constriction and its yellow color becomes more evident here. See Fig. 3. Needless to say, therefore, the amalgamated lips are fixed, and shut closely around the anterior extremity of the onchium. Whether the lip region is innervated remains unknown, but no innervations have been seen. The tylenchoid *pharynx is of a very robust nature* and reminiscent of that of *Nemonchus.* The base of the onchium, or spear, thirteen microns wide by ten high, is very distinctly three bulbed and is about one-fifth as wide as the corresponding portion of the head. *Each of the three bulbs is anteriorly somewhat "lobed,"* presenting sometimes two and sometimes three rather distinct forward pointing knobs. Owing to its index of refraction this lobed base of the onchium, as well as the "hilt," are almost totally invisible in balsam mounts; while the acute tapering anterior part remains distinctly visible,—another evidence of the two-fold character (and origin) of the tylenchoid onchium. The posterior attachment of the musculature comprising the *ellipsoidal pharyngeal bulb,* which is one-half as wide as the head, is not only to the front portion of the bulbs of the onchium but also to their posterior surfaces. The hilt is about half as wide as the bulbous base; the anterior end of the spear is blunt, and the lumen relatively unusually narrow;—all which makes the spear an unusually substantial structure, capable of puncturing tissues offering considerable resistance. In harmony with this, the ellipsoidal to obpyriform *spear guide is of strong construction,* consisting in part of six outwardly bowed elastic elements surrounding the anterior third of the spear and springing backward from the base of the cutinized lip region. (Figs. 2 and 3.) This six-fold spear guide has a variable length and width, its form changing with the attitude of the spear;—when at rest, with a length of fourteen microns, its width is about eight microns,—that is, it is about one-third as wide as the corresponding portion of the head. In addition to this spear guide the cutinized lip-region fits closely around the anterior portion of the spear for a considerable distance. Both the spear and the spear guide appear to present traces of transverse striation corresponding in fineness with the minute subdivisions of the annules sometimes visible in the subcuticle. The two parts of the spear are rather distinctly set off from each other by a very fine transverse junction mark, as in many *Tylenchi.* No amphids, deirids or phasmids have been seen. There are no eyespots. The oesophagus is tylenchoid, presenting however, as already indicated, a rather distinct pharyngeal bulb, something rather uncommon in the *Tylenchidae.* The spherical or oblate median oesophageal bulb is half as wide as the corresponding portion of the neck, and is set off both fore and aft from the remaining narrow portions of the oesophagus,—very abruptly behind and rather abruptly in front. Behind the median bulb the narrow oesophagus gradually enlarges to form a rather obscure posterior

long-clavate swelling which at its widest part is one-fourth as wide as the base of the neck. It is however natural to imagine the swollen salivary glands to be joined with this inconspicuous posterior portion of the oesophague and thus at first to get an idea that the posterior part of the oesophagus comprises a wide clavate swelling, three-fourths as wide as the base of the neck. We may say therefore that the oesophagus behind the pharynx is about one-seventh, at the nerve-ring also about one-seventh, and finally about one-fourth as wide as the corresponding portion of the neck. The lining of the oesophagus is a distinct feature arteriorly and consists of a narrow highly refractive tube; posteriorly the lining is inconspicuous. The musculature is fine and colorless. There are *three salivary glands* clustered opposite the posterior two-fifths of the oesophagus. One of these cells comprises the anterior portion of the cluster, while the other two may lie more or less opposite each other as the posterior part. The salivary glands are very well developed, and two of them, submedian, empty through ducts into the base of the valve of the median bulb, while the third, the dorsal, passes forward and empties into the dorsal side of the oesophageal lumen not far behind the base of the onchium. At the mouth of each duct *a faint ampulla* is usually visible. The median oesophageal bulb presents a spheroidal, simple, strongly refractive valve one-sixth as wide as the bulb itself. There is no distinct cardia. The thick-walled intestine, which presents a distinct refractive lumen, is not set off from the oesophagus by a cardiac collum, the change from oesophagus to intestine being gradual. The intestine has its cells closely packed with granules of variable size, the largest being one-twelfth to one-sixteenth as wide as the body. These colorless, non-birefringent, spherical granules *gradually decrease in number* in the cardiac region and cease altogether opposite the posterior portion of the salivary glands; they are sometimes so arranged as to give rise to a tessellated effect. The intestine somewhat gradually becomes four-fifths as wide as the body, and is composed of cells of such a size that two to three are presented in each cross section. The cells of the intestine are so closely packed with granules as to make it difficult to examine successfully in living specimens details of the anatomy of adjacent organs. The exceedingly small *anus and the rectum are very inconspicuous.* There is no pre-rectum. The *tail is of an elongate hemispheroid form,* very broad and rounded at the extremity, and symmetrical. There is no spinneret and there are no caudal glands. Measured at the latitude of the nerve-ring, the lateral chords are as wide as the cuticle is thick, or wider; somewhat farther back, they are about one-third as wide as the body. They contain scattered colorless refractive spherical granules of variable size, considerably smaller than those of the intestine. Behind the base of the neck, at a distance about equal to the diameter of the body, there is a cell which presses the intestine well to one side. This cell is about as long as wide but not spheroidal. It is finely granular, one-half as wide as the body, and seems very probably to be connected with the renette. The *excretory pore,* which is opposite the base of the neck, is rather distinctly to be seen, though of small size. It lies between two annules, and the nearer striation swerves a little to one side for it. The renette duct leads *inward and to the right* along the right lateral chord. From the somewhat depressed, rather large and rather conspicuous vulva, which is a transverse slit two-fifths as long as

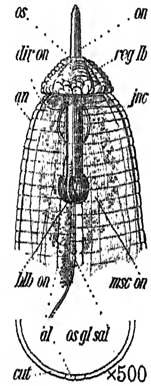

FIG. 3. Nearly lateral view of *H. coronatus* n. sp. Below, a semi-contour of the body in the same region, showing the double wing.

the body is wide, the strongly cutinized medium sized vagina extends inward at right angles to the ventral surface half the way across the body. From toward the ends of the valvular opening *four muscles pass obliquely* to the ventrally submedian regions of the body, two forward and two backward, - two to the right and two to the left. Furthermore there are two *transverse* valvular muscles attached near the ends of the opening and fanning out to the lateral parts of the body wall, one right and the other left, each partially encircling the intestine. Each of the two outstretched uteri, about two body-widths long and about one-fourth as wide as the body, at its distal extremity presents a spermatheca three-fourths as wide as the body, sometimes containing what appear to be toward one hundred sausage shaped sperm cells each sometimes having a bunch of chromosomes at one end. These spermatheca are located at a distance from the vulva two or three times as great as the diameter of the body. In the late autumn they are a very uniform feature of the adult females which have deposited no, or very few, eggs. As thus far seen, the slender outstretched ovaries are about one-fourth as wide as the body; both lie on the left side. They are narrow and somewhat cylindroid and contain one hundred or more ova arranged somewhat irregularly.

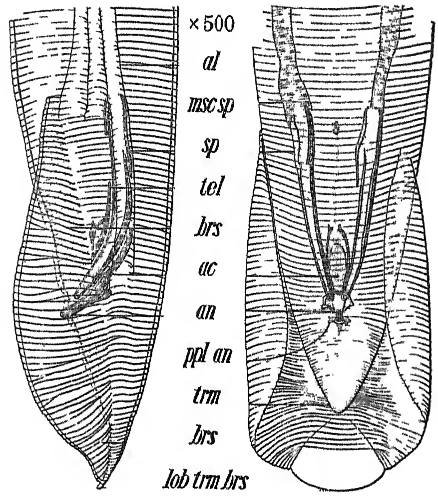

FIG 4 Lateral and ventral views of the tail end of the male of *Hoplolaimus coronatus* n sp Treated with potassium hydrate to obliterate non-cutinized structures

$$\frac{3.4}{2.4}\;-\;\frac{8.9}{2.8}\;=\;\frac{13.}{3.2}\;-\;-\;\frac{\overset{47}{-}\mathrm{M}}{3.5}\;-\;-\;\frac{97.3}{2.2}\;\;1.4\,\mathrm{mm}$$

The male is like the female in form. The spicula are colorless. A portion of the gubernaculum lies ventrad,— (telamon of Hall). See Fig. 4. There are no preanal ventral supplementary male organs, and no ribs occur in the bursa. The striae of the bursa on the ventral side are less distinct near the ventral line. The terminal lobe of the bursa appears destitute of striation; if any striae are present they must be exceedingly fine. The vas deferens appears to be about one-half as wide as the body. The narrow cylindroid testis tapers a little, and at the blind end is only one-fourth as wide as the body. The granular sperm cells seen in the vas deferens are about one-tenth as wide as the body; the spermatocytes, farther forward, one-eighth.

Habitat: Found in soil immediately about a Mermis "nest," (*Agamermis decaudata*), Four Mile Run, Falls Church, Va., U.S.A. Nov., 1922.

The movements of this nema are very slow. The limber body readily takes on sharp sigmoid curves and is sometimes seen coiled; in fact the males can coil rather closely. From this amended characterization it seems evident the *Hoplolaimus* Daday (not of other authors) is a rather clearly marked genus. The closest relative of *Hoplolaimus is Dolichodorus* Cobb 1914.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

878TH MEETING

The 878th meeting was held in the Cosmos Club Auditorium on Saturday, February 10, 1923, with President White in the chair and 43 persons in attendance.

Mr. G. W. LITTLEHALES addressed the Society on *New resources to lighten the labor of navigators in finding geographical position from observations of celestial bodies.* The paper was illustrated by lantern slides and was discussed by Messrs. RUDE, LIFEROCK, and PETERS.

Author's abstract: Included in the equipment of navigators are instruments for measuring the altitude of celestial bodies above the horizon and also chronometers or watches intended to show, from instant to instant, the time of day at the meridian of Greenwich.

An observer who has determined the altitude of a celestial body at a given instant of time has in reality located himself at the end of a radius whose length is the zenith distance, or 90° minus the altitude of the celestial body, and whose origin or center is the geographical position of the observed celestial body, or that place on the surface of the earth which is vertically under the observed body at the instant of observation. In the absence of knowledge of the precise direction of the radius, the only definite information to be obtained from the observation of the altitude of a celestial body at a given instant is that the observer is located on the circumference of a circle described by the radius.

Each separate altitude and corresponding Greenwich time of observation, whether it be of a different celestial body or of the same celestial body in a different quarter of the heavens, will result in one of these circles of position; and it is by the intersection of the circumferences of two or more of these circles that the actual geographical position of the observer is fixed.

Of course, if the observer has migrated in the interval between two observations, it will be necessary, in order to find his geographical position at the instant of the second sight, to consider the center of the first circle of position to be moved in a direction represented by his true course between the stations and by an amount equal to the distance between them.

These circles are called Sumner circles or circles of equal altitude since the circumference of each traces out a line on the earth's surface from every point in which the altitude of the observed celestial body is the same at the time of observation. In practice it is unnecessary to draw the whole of the circumference corresponding to each observation.

Every part of the Sumner circle is perpendicular to the true bearing of the celestial body observed, and therefore the azimuth of the body observed is equal to the angle which the Sumner line makes with the parallels of latitude on the Mercator chart. Hence, if the latitude and longitude of one point in the Sumner line be known, and also the true azimuth of the observed position, the line may be drawn on the chart.

The process by which the longitude corresponding to a given latitude, or rather the relative longitude or hour angle, and also the azimuth are calculated is simply the solution of the spherical triangle whose sides are the estimated co-latitude, the zenith distance or co-altitude, and the polar distance or co-declination. These three sides are the data: the results to be calculated are the hour angle of the celestial body from the ship's meridian, and the azimuth.

It is evident that if the solutions of these two angles are tabulated corresponding to all the usual values of each of the three sides of the triangle, there will be no need for any calculation, and, hence, that a simplification is afforded in obtaining the data for drawing the Sumner line by the new *tables of simultaneous hour angles and azimuths* in which are given the values of the hour angle and azimuth that a celestial body would have at stated true altitudes above the horizon of an observer situated in successive degrees of latitude ranging from 60° north to 60° south of the equator.

Mr. C. V. HODGSON presented a paper on *Precise measurement of distances on the earth.* The paper was illustrated by lantern slides and was discussed by Messrs. WM. BOWIE, RUDE, PAWLING, TUCKERMAN, HUMPHREYS, HAWKESWORTH, FERNER, and GISH.

Author's abstract: The first part of the paper was a brief résumé of the earlier methods of precise distance measurements with reference to the approximate accuracy obtained with each. Lantern slides were shown of the contact bar, duplex bar, wire bar and tapes, with references to the principal mechanical and theoretical features of each, and their advantages and disadvantages.

A recent extension of the principles of precise base measurement to precise traverse was then discussed. About 3000 miles of precise traverse has been executed in the United States by the Coast and Geodetic Survey in regions where triangulation would be very expensive. The accuracy of this traverse, as measured by closure in position, is usually from 1–70,000 to 1–100,000. The cost will range from $38.00 to $60.00 per mile, and the speed with the single party from 60 to 120 miles per month.

As an indication of the accuracy which may be obtained with invar tapes, reference was made to a precise base being measured in California where the accuracy desired is represented by an actual error of 1 part in 1,000,000 with a probable error of about 1 part in 4,000,000. Such accuracy necessitates unusual refinement in methods, some of which consist of special standardizations of tapes and bars, corrections for the temperature of the springs and the balances, investigations as to the amount of error resulting from slight errors in tension, temperature and inclination of tapes, and special field methods to limit such errors.

Mr. R. W. G. WYCKOFF presented two papers, (1) on *Atomic radii*, and (2) on *Crystal structure of the alums.* The papers were illustrated by lantern slides and were discussed by Messrs. TUCKERMAN, WILLIAMSON, SOSMAN, and GISH.

Author's abstract: A comparative study has been made of the best available crystal structure data to see whether they are in agreement with the hypothesis of constant atomic radii advanced two years ago by W. L. Bragg. According to this hypothesis if a definite size is assigned to the atoms of the various elements, crystals can be built up by packing together these atomic spheres. The existing data show clearly that this idea is not satisfied by the better information now at hand. They do, however, conform quite exactly to the rule that in isomorphous crystals composed of only two kinds of atoms the interatomic distances have additive properties which can be illustrated through a summing up of "atomic radii." The rule often holds approximately between the most electropositive and electronegative atoms of a crystal but deviates widely in its application to the other atomic separations. In crystals of different sorts the effective volume of an atom depends both upon the nature of the other atoms with which it is associated and the manner of their distribution about it. These data seem to show furthermore

that the more nearly alike is this atomic environment in the two cases, the closer together are the "atomic radii" of an atom occurring in both.

Author's abstract: Laue photographic studies upon potassium and ammonium aluminum alums show that the previous X-ray spectrometer data (Vegard and Schjelderup) are incorrect and assign an incorrect atomic arrangement. A comparison of the spectrometer measurements with some spectrographic observations proves that the spectrometer inaccuracies arise from the entrance of reflections from other than the principal reflecting face into the ionization chamber. This difficulty is pointed out to be one inherent in the spectrometer technique itself so that the alums thus furnish an excellent and clear-cut illustration of the insufficiency of the original spectrometer procedure for the determination of the structures of crystals using X-rays.

The unit cube of the correct structure contains four molecules of the composition $RAl(SO_4)_2 \cdot 12HO_2$, where R is either K or NH_4. The 12 water molecules fall into two groups of six each. The hydrogen atoms in the ammonium group present an interesting difficulty in the impossibility of arranging them into a chemically plausible radical which will possess a symmetry in keeping with that of the crystal as a whole. For these crystals the corresponding space group is T_h^6.

879TH MEETING

The 879th meeting was held in the Cosmos Club Auditorium on Saturday, February 24, 1923. It was called to order by President White with 24 persons present.

Owing to some delay at the projecting lantern, opportunity was afforded for informal communications. Mr. I. G. PRIEST presented an informal communication on a new variation in the use of the Nicol prism. Dr. W. J. HUMPHREYS presented an informal communication on a correct explanation of the diffraction phenomenon commonly known as the "glory" or "Brockenbow."

Dr. C. G. PETERS presented a paper on *Changes in the index of refraction of glass at high temperature.* The paper was illustrated with lantern slides and was discussed by Messrs. WILLIAMSON, GISH, HUMPHREYS, WASHBURN, HAWKESWORTH, WHITE, and SOSMAN.

Author's abstract: Using an interference method the changes in the refraction of nine different kinds of optical glass were measured over the temperature interval 20° to 650°C.

The samples made in the form of a plate having two faces parallel were placed between two fused quartz mirrors and heated in an electrical furnace. The index at any temperature can be represented by the relation

$$\mu_t = \frac{N_g + \Delta N_g}{N\nu + \Delta N\nu}$$

Where $N\nu$ is the number of light waves between the fused quarz plates at 20°C., N_g the number of waves in glass between the two parallel surfaces of the plate at the same temperature, ΔN_ν the number of fringes that pass the reference mark on the quartz plates, and ΔN_g the number that pass reference mark on the glass plate while the temperature is increased to t.

The index of each glass increased with the temperature until the annealing range was reached which was near 500°C. for these glasses. As the temperature was still further increased, the index decreased rapidly. The rapid

decrease in the index between 500 and 650°C. is due to the decrease in density caused by the rapid increase in the expansivity of glass in this region.

It is usually assumed that the index changes according to the relation $\frac{\mu - 1}{d} = C$ or a similar relation. With glass, however, the index increased between 20 and 500°C., while the density decreased. This increase in index must be due to the same influence that causes the ultra-violet absorption band to move toward the longer wave-length region when glass is heated. The effect of this cause must be the difference between the measured value for the index and the value computed from the density relation. This was found to increase at a constant rate even through the critical region between 500 and 600°C.

By invitation, Mr. C. C. Kiess presented a paper on *Regularities in the sprectra of chromium and molybdenum.* The paper was illustrated with lantern slides and was discussed by Messrs. Mohler, Hawkesworth, Meggers, Sosman, and Humphreys.

Author's abstract: The elements in whose spectra series have been found fall, with a few exceptions, in the first three columns of the Periodic Table. The unravelling of series relationships in the spectra of the other elements has been delayed partly because of the complexity of their spectra but chiefly by the lack of reliable wave-length data in the spectral regions to the red of wave-length 6000 A. Recent studies of the arc spectra of chromium and molybdenum at the Bureau of Standards have led to the discovery of series and other regularities in them. The same types of series exist in both spectra. In each spectrum, there are two systems of series whose members are widely separated triplets. Each system consists of a principal, sharp, and diffuse series, the members of which are separated from the homologous members of the second or parallel system by constant frequency differences. For chromium the characteristic triplet separations are $\Delta\mu_1 = 112.4$, $\Delta\mu_2 = 81.4$ and $\Delta\nu_1' = 115.1$, $\Delta\nu_2' = 91.4$; while for molybdenum the corresponding data are $\Delta\nu_1 = 448.5$, $\Delta\nu_2 = 257.5$ and $\Delta\nu_1' = 379.9$, $\Delta\nu_2' = 233.4$. In addition to the wide triplets, each spectrum contains narrow triplets of which the separations are $\Delta\surd_1 = 8.8$, $\Delta\surd_2 = 5.6$ for chromium, and $\Delta\nu_1 = 121.5$, $\Delta\nu_2 = 87.0$ for molybdenum. Besides the series regularities there exist in each spectrum other regularities known as multiplets. These consist of groups of nine or twelve lines linked together by constant frequency differences. Since more lines of the spectra of these elements have been assigned to multiplets than to series, it would seem to indicate that the multiplet rather than the series type of regularity is the predominant one in complex spectra.

880th meeting

The 880th meeting was a joint meeting with the Washington Academy of Sciences held in the Cosmos Club Auditorium on Saturday, March 10, 1923.

President Vaughan of the Washington Academy of Sciences took the chair with 90 persons in attendance.

Dr. Briggs introduced Professor A. Sommerfeld of Munich, who addressed the joint meeting on the subject *Evidence for the theory of relativity afforded by atomic physics.* The address was illustrated with lantern slides and was discussed by Messrs. Bauer, Mohler, Hawkesworth, and Foote.

On motion of Dr. Briggs, the joint meeting accorded Professor Sommerfeld a rising vote of thanks for his address.

881ST MEETING

The 881st meeting was held in the Cosmos Club Auditorium on Saturday, March 24, 1923. It was called to order by Vice-President Hazard with 50 persons in attendance.

Mr. J. PAWLING presented a paper on *The 9″ Transit of the U. S. Naval Observatory and its work.* The paper was illustrated with lantern slides and was discussed by Dr. HUMPHREYS.

Mr. H. A. MARMER presented a paper on *The tidal phenomena in New York harbor.* The paper was illustrated with lantern slides and was discussed by Messrs. HUMPHREYS and GISH.

Author's abstract: In New York Harbor the tidal and current phenomena exhibit more than usual variety because of two geographic features that distinguish the harbor: (a) Unlike other harbors which generally consist of a tidal bay or river New York Harbor comprises a system of five tidal highways that connect with the open sea by means of two inlets many miles apart; (b) the waterways forming the harbor—Upper Bay, Kill van Kull, East River, Harlem River and lower Hudson River—are either intercommunicating or lead into other bodies of water.

In Upper Bay and in the lower Hudson the tidal and current phenomena are typical of those found in bays and rivers in which the tidal movement is of the progressive-wave type. The time of tide becomes later in going up stream at a rate dependent on the depth, the formula being approximately $r = \sqrt{gd}$, where r is the rate of advance, g the acceleration of gravity and d the depth of the waterway. The mean range of the tide decreases in going upstream, and the strength of current comes about the times of high and low water.

In the East River, the tide changes by $3\frac{1}{4}$ feet through the stretch of 14 geographic miles but not at a uniform rate. The range of tide is 4.4 feet at the eastern end and 7.2 feet at the western, but in the river near the western end is a region with a range of 4.0 feet. The strength of the current is very nearly simultaneous throughout the river.

It has been customary to ascribe the tidal and current phenomena in the East River to the interference of two tide waves, the one coming from Long Island Sound and the other from Upper Bay. But these phenomena can easily be derived by considering the matter from the hydraulic point of view and a slope-line diagram brings out the principal tidal and current phenomena immediately.

The tidal and current phenomena in the Harlem River and in Kill van Kull, as in the East River, are conditioned by the fact that the tidal movement in these waterways is largely of the hydraulic type.

A brief description was given of a bifilar suspension direction indicator used in determining the direction of subsurface currents.

Dr. F. E. WRIGHT presented a paper on *Methods for distinguishing between natural and cultivated pearls.* Specimens of both natural and cultivated pearls were exhibited, and the paper was discussed by Messrs. TUCKERMAN, IVES, RUDE, and HUMPHREYS.

Author's abstract: The cultivated pearl from Japan consists of a center or nucleus of mother-of-pearl or of an inferior pearl, on which thin concentric shells of pearly substance have been deposited by the shell secreting epidermis of the pearl oyster; it differs from the normal fine pearl of commerce only in the fact of its foreign nucleus; the fine pearl consists of the thin concentric shells of the pearly substance throughout. Any method for

distinguishing between cultivated and fine pearls must be based on some property that brings out the inhomogeneity between the foreign nucleus and the pearl periphery in the cultivated pearl. If the nucleus is a bead of mother-of-pearl the fact that the mother-of-pearl reflects the light strongly along a direction normal to the pearly layers and weakly along other directions can be used as a criterion. Under proper conditions of illumination the characteristic mother-of-pearl sheen can be seen shining out as a subdued glow from the nacre bead of a cultivated pearl when held in certain positions. In transmitted light the corresponding differences in degree of transparency for directions normal and parallel with the pearly layers of the nacre bead can be used to reveal its presence. Under intense illumination the banding of the mother-of-pearl nucleus gives rise to a series of bright lines on a dark field when the pearl is held in a certain position. Intense illumination is obtained by use of a strong artificial light or the sun focussed by means of a condenser lens on the pearl. The pearl may be examined in air or immersed in a refractive liquid. Polarized light was found to be of no assistance except for cutting out glare due to extraneous light.

A third method is a modification of the method of Galibourg and Ryziger for examining the walls of the hole drilled through the pearl. In place of the mercury column which they employed a bead made by fusing the end of a pure gold wire 0.2 mm. diameter is used as a reflecting mirror. By its use any irregularities or changes in the substance lining the hole in the pearl can be seen reflected by the gold bead when examined under proper conditions of illumination through a low power microscope or binocular.

882ND MEETING

The 882nd meeting was held jointly with the Washington Academy of Sciences, the Washington Society of Engineers, and the American Society for Steel Treating in the auditorium of the Interior Building on Saturday, March 31, 1923.

The chair was taken by President WHITE of the Philosophical Society with 150 persons in attendance.

Dr. WALTER ROSENHAIN, F. R. S., of the National Physical Laboratory, addressed the meeting on *The structure and constitution of alloys*. The address was illustrated with lantern slides and was followed by discussion.

J. P. AULT, *Recording Secretary*.

SCIENTIFIC NOTES AND NEWS

The National Academy of Sciences met at the National Museum April 23–25. On the evening of April 23 an address was given by Dr. W. W. CAMPBELL: *Résumé of results obtained by the Crocker Eclipse Expeditions from Lick Observatory.* A reception followed in the galleries of the Museum.

The annual meeting of the American Geophysical Union was held at the Carnegie Institution on April 17–19. The following sections held meetings: Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Oceanography, Volcanology, and Geophysical Chemistry.

At the Bureau of Standards Physics Club on Wednesday, April 18, Professor R. A. MILLIKAN spoke on *The penetrating radiations of the upper air.*

Dr. L. SILBERSTEIN lectured on *The helium atom* at the Bureau of Standards, Monday, April 23.

The following two meetings were held in the Assembly Room of the Carnegie Institution. Thursday, April 19. Program: R. A. MILLIKAN: *Present problems in the field of atomic structure and their bearing upon the nature of ethereal radiations.* Wednesday, April 25. Program: A. A. MICHELSON: *Application of interference methods to astronomy.*

In connection with the annual meeting of the Association of Scientific Apparatus Makers, held in Washington on April 20, there was an exhibit of apparatus in the Industrial Building, Bureau of Standards. A number of manufacturers displayed some of their newer developments.

Dr. SVEN HEDIN, the Swedish explorer, gave a talk in the National Museum on Wednesday, April 18, on *Discoveries in Eastern Turkistan and Southern Tibet.*

Dr. GEORGE KIMBALL BURGESS has been appointed director of the Bureau of Standards, to succeed Dr. S. W. STRATTON. Dr. Burgess entered the Bureau as assistant physicist in 1903, was associate physicist from 1905 until 1913, when he became chief of the Division of Metallurgy, which position he has held up to the present time.

At the meeting of the American Philosophical Society in Philadelphia on April 11 the John Scott medal and prize were awarded by the City of Philadelphia to Dr. ARTHUR L. DAY, director of the Geophysical Laboratory, Carnegie Institution of Washington, for his work in the interpretation of geological phenomena and for producing optical glass.

Mr. NEIL M. JUDD, curator of American Archeology, U. S. National Museum, will leave Washington May 1 to resume direction of the National Geographic Society's expedition for the exploration of Pueblo Bonito, one of the largest and best preserved prehistoric ruins in the southwestern United States.

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BOTANY.—Dissanthelium, *an American genus of grasses.* A. S. HITCHCOCK, Bureau of Plant Industry.

The genus *Dissanthelium* is interesting because of the peculiar distribution of its three species and because of the confused nomenclature of the original Peruvian species.

Of the three species now referred to this genus, two are found in the Andes of Peru and Bolivia, one occurring also in Mexico, and a third is confined to islands off the southern coast of California.

The genus was originally described by Trinius in 1836, based upon a single species, *D. supinum*, from Peru, "in frigidissimis ad Cerro de Pasco (America calidiore, *Poeppig*)," and is characterized by the two awnless florets, exceeded by the equal glumes. Cerro de Pasco is north of Lima.

The California species is an annual (30 to 40 cm. tall), with flat blades, growing at low altitudes. The other two species are dwarf alpine plants with narrow often folded or involute blades, *D. calycinum* being a cespitose perennial and *D. minimum* an annual.

The type species of the genus was first described by Presl under *Brizopyrum* and was soon after transferred to *Poa* by Kunth, apparently without having seen the plant. The writer examined the type specimen of Presl's species at the herbarium of the German University in Prague and found that it was the same as the type of Trinius's species, which he examined in the herbarium of the Academy of Sciences at St. Petersburg. On grounds of priority the older name must be adopted. The second Peruvian species was first given a name by Steudel without description and the plant was distributed by Hohenacker in his exsiccatae (Lechler, Plantae Peruvianae, no. 1836) as *Vilfa macusaniensis* Steud. Later Pilger described the same species as *Dissanthelium minimum*, basing it on Weberbauer's no. 5451 from Peru.

The synonymy of the species is given below:

1. Dissanthelium californicum (Nutt.) Benth. in Hook. Icon. Pl. III. 4: 56. *pl. 1375*. 1881. Based on the next.
   Stenochloa californica Nutt. Journ. Acad. Phila. II. 1: 189. 1848. Type from Santa Catalina Island, *Gambel*.

Dr. B. L. Robinson has kindly sent to the U. S. National Herbarium a tracing of the type specimen in the Gray Herbarium and a fragment of the inflorescence. The specimen is about 25 cm. tall but without the roots, bearing three flat, lax blades and a narrow panicle 10 cm. long. One of the spikelets in the fragment sent contains three florets. The label reads, "**Stenochloa poaeoides*. Catalina, Calif." The asterisk indicates a new species, according to Nuttall's usual method, but the specific name was changed in publication to *californica*. This species does not appear to be closely related to the other two, but it does not seem to be sufficiently different to constitute a distinct genus.

The only specimen in the U. S. National Herbarium is from San Clemente Island, California (*Trask* 324). The specimen from Tassajara Hot Springs (*Elmer* 3317), cited in Jepson's Flora of California (1:141. 1912), proves to be *Poa howellii* Vasey & Scribn.

2. **Dissanthelium calycilum** (Presl) Hitchc.
   Brizopyrum calycinum Presl, Rel. Haenk. 1: 281. 1830. Locality not known but probably Peru.
   Poa calycina Kunth, Rév. Gram. 1: Suppl. XXVIII. 1834. Based on the preceding.
   Dissanthelium supinum Trin. Linnaea 10: 305. 1836. The type from Cerro de Pasco, Peru.
   Deschampsia mathewsii Ball, Journ. Linn. Soc. Bot. 22: 60. 1885. Type from the Peruvian Andes, collected by Mathews.
   Dissanthelium sclerochloides Fourn. Mex. Pl. 2: 112. 1886. Fournier mentions two specimens, Nevada de Toluca, Hahn, and San Luis de Potosí, *Virlet* 1434, neither of which I have seen.

In the U. S. National Herbarium are the following specimens of this species: Mexico: Nevada de Toluca, *Pringle* 4222; Ixtaccihuatl, *Purpus* 1633. Peru: Piñasniocj, *Cook & Gilbert* 1297, 1305; Casapalta, *Ball* in 1882 (a fragment from a duplicate type in the Gray Herbarium). Bolivia: Without locality, *Bang* 1873.

3. Dissanthelium minimum Pilger, Bot. Jahrb. Engler 56: Beibl. 123: 28. 1920. The type from the mountains of Peru, between Pisco and Ayacucho (*Weberbauer* 5451).
   Vilfa macusaniensis Steud.; Lechl. Berb. Amer. Austr. 56. 1857 (*nomen nudum*). This work is primarily an account of the genus *Berberis* in South America. Appended to this is a list of the plants collected in South America by Lechler, classified according to countries, each name followed by the number of the species in Lechler's exsiccatae as issued by Hohenacker. In this case the name is under the Peruvian collection and the number is 1836.

Graminastrum macusaniense Krause, Beihefte Bot. Centralbl. 32: 348. 1914. This name is based on *Vilfa macusaniensis* Steudel. The generic name used had not previously been published. There is no generic description.

In the U. S. National Herbarium there are two specimens, one a part of the type of *D. minimum* (*Weberbauer* 5451) kindly sent by Dr. Pilger, the other a specimen of Lechler's 1836, contributed from the Vienna Herbarium by Dr. Zahlbruckner.

ZOOLOGY.—*A new* Anolis *from Haiti.* DORIS M. COCHRAN, U. S. National Museum. (Communicated by DR. L. STEJNEGER.)

In a collection of reptiles made in Haiti by the late J. B. Henderson and Dr. Paul Bartsch during their expedition of 1917, there is a specimen of a very handsome *Anolis*, which seems to represent a species as yet undescribed.

Anolis hendersoni, new species

Diagnosis.—Dorsal scales granular, the 4 or 5 median rows slightly enlarged; length of tibia much less than distance between tip of snout and ear; ventrals smooth; tail slightly compressed, nearly three times the length of head and body.

Type.—Adult male, U. S. N. M. No. 59210; Petionville, Haiti; J. B. Henderson and Dr. Paul Bartsch, collectors; April 1, 1917.

Description.—Head elongate, its greatest width contained twice in distance from ear to tip of snout; nostrils lateral, their distance from tip of snout equalling one-sixteenth of head-length; top of head with two very low, diverging frontal ridges, reaching nearly to nostrils and enclosing an elongate depression; head-scales without keels, except the 7 or 8 enlarged supraoculars, which have blunt keels; rostral rather large, its superior border curved; 6 or 7 narrow scales in a row between nostrils; supraorbital semicircles composed of 5 large scales diminishing in size posteriorly, separated from each other in the median line by a single row of small scales, and from supraoculars by one row of very small scales; occipital considerably smaller than ear-opening, separated from supraorbital semicircles by about 4 rows of scales; 6 elongate scales on canthus rostralis; superciliary ridge consisting of one extremely long shield and some granules; loreal rows 6 or 7; scales of suborbital semicircles bluntly keeled, broadly in contact with supralabials; 6 supralabials to a point below center of eye; 7 lower labials; one pair of mental shields, wider than the rostral; temporal granules about the size of laterals; a well-marked series of small scales forming the supratemporal line; a distinct dermal fold from occiput to tail, covered by 4 or 5 rows of enlarged granular scales, with the median row keeled; the remaining dorsal scales granular; the laterals extremely minute; granules on nuchal region between occiput and shoulders coarse, nearly as large as the largest dorsals; ventral scales moderately large, flat, transversely oblong or pentagonal; scales on throat and breast smaller and slightly keeled; fore legs with small keeled scales above; anterior scales of femur enlarged, keeled, gradually diminishing posteriorly and below; scales covering hands and feet above multicarinate; digital expansion wide, 35 lamellae under fourth toe and 17 under fourth finger; tail long, very slightly compressed, without verticils or serrated edge;

postanal scales well developed; gular pouch rather small, probably not very extensible; a transverse fold across throat, and two others in front of shoulder; hind limb reaches to front of eye; fore limb reaches three-fourths the distance to groin.

Dimensions.—Total length, 174 mm.; tip of snout to vent, 46 mm.; vent to tip of tail, 128 mm.; tip of snout to ear, 16 mm.; tip of snout to center of eye, 10 mm.; width of head, 8 mm.; fore leg, 17 mm.; hind leg, 36 mm.; tibia, 12 mm.; anterior border of nostril to tip of snout, 1 mm.

Coloration (in alcohol).—Top of head and neck drab; a dark lateral streak from rostral, turning to purple behind eye and suddenly narrowing above the shoulder to a black line continuing to groin; the nuchal region between these dark streaks marbled with dark bluish-gray to the shoulders, where the marblings suddenly cease, leaving the back and tail a uniform unspotted gray; below the dark lateral streak a sharply-defined white stripe beginning on upper lip below eye and continuing backwards to hind leg, bordered beneath from axilla to groin by a narrow dark line, the lower edge of which is produced into dark grayish-blue marblings, in which are anastomosing white spots; ventral surface pale blue; the lower labials white, flecked with light gray marblings; limbs pale and unspotted, with dusky bands across the digits above.

The new species apparently belongs to the same group as the Cuban *Anolis alutaceus* Cope, but it can be immediately distinguished from *A. alutaceus* by its much longer snout and its distinctive coloration. A long-snouted species from Navassa, *A. longiceps* Schmidt, may be related to *A. hendersoni.* The distance of the nostril from the tip of the snout is one-fifth the headlength in *A. longiceps,* and one-sixteenth the headlength in *A. hendersoni,* and so there is no possibility of confusing the two. The new species is named after the late J. B. Henderson, in recognition of the invaluable services he rendered to science during an all-too-short career. It is fitting that this exceptionally handsome *Anolis,* conspicuous even in a genus of unusual daintiness and beauty, should perpetuate his name in the region which he loved to explore.

ORNITHOLOGY.—*Descriptions of New East Indian Nectariniidae.*

HARRY C. OBERHOLSER, Biological Survey.

Study of the collection of East Indian sunbirds in the United States National Museum has brought to light a number of new forms. These are described in the following pages.

Measurements are all given in millimeters, and have been taken as in the author's previous papers. The names of colors are based on Ridgway's *Color standards and color nomenclature.*

Arachnothera affinis heliophilus, subsp. nov.

Subspecific characters.—Similar to *Arachnothera affinis affinis* from Java, but smaller; upper surface more greenish (less yellowish); and the anterior lower parts less distinctly streaked.

Description.—Type, adult male, No. 179384, U. S. Nat. Mus.; Loh Sidoh Bay, northwestern Sumatra, November 6, 1901; Dr. W. L. Abbott. Upper parts yellowish citrine; tail fuscous black, the basal three-fourths of middle rectrices and the basal two-thirds of remaining feathers, yellowish dark citrine, and subterminal spots on four outer rectrices creamy white; wings fuscous, edged with yellowish citrine; lores, sides of head and of neck, like the back, but the auriculars somewhat grayish; lower parts between light olive gray and light grayish olive, streaked with fuscous, and on the medial posterior portion with olive buff, but the middle of the abdomen plain olive buff; crissum critine drab, the feathers tipped with olive buff to deep olive buff; lining of wing pale brownish, outwardly mixed with fuscous and colonial buff; axillars olive buff.

Measurements of type.—Wing 81 mm.; tail, 48; exposed culmen, 33; tarsus, 18; middle toe without claw, 12.

While this new race is intermediate between *Arachnothera affinis affinis* of Java and *Arachnothera affinis modesta* of the Malay Peninsula, it is different enough from both to be separately recognized. It may be distinguished from the latter by its smaller size, darker upper surface, and rather darker lower parts. It is the form inhabiting most if not all of Sumatra.

Arachnothera chrysogenys astilpna, subsp. nov.

Subspecific characters.—Similar to *Arachnothera chrysogenys chrysogenys*, from eastern Sumatra, but upper parts darker, duller, and less yellowish (more grayish); lower surface rather darker.

Description.—Type, adult male, No. 173289, U. S. Nat. Mus.; Bok Pyin, Tenasserim, February 14, 1900; Dr. W. L. Abbott. Upper parts olive citrine; tail dark citrine, the shafts of the feathers fuscous; wings fuscous, with edgings of citrine and dark citrine; the inner lesser coverts olive citrine; supra-ocular streak and auricular patch, lemon chrome; remaining portions of sides of head and of neck like the back in color; anterior lower parts warbler green, but streaked with the grayish of the base of the feathers, which in places shows through; sides and flanks olive yellow; the middle of abdomen and middle of lower breast, wax yellow; crissum similar, but inclining a little to citrine; lining of wing light fuscous, washed with straw yellow; "feet fleshy brown; bill dark horn brown, yellow along commissure."

Measurements of type.—Wing, 81 mm.; tail, 39.5; exposed culmen, 36.5; tarsus, 19; middle toe without claw, 13.

This race occupies apparently all of the Malay Peninsula.

Arachnothera longirostris antelia, subsp. nov.

Subspecific characters.—Similar to *Arachnothera longirostris longirostris*, from Burma, but upper surface duller, less golden (more greenish), and rather darker; yellow of posterior lower parts lighter, brighter, and more greenish.

Description.—Type, adult male, No. 169920, U. S. Nat. Mus.; Trang, Lower Siam, January 1, 1899; Dr. W. L. Abbott. Upper parts rather dark citrine, the centers of the feathers on the pileum fuscous, their edgings dark citrine; tail dark fuscous, edged with dark citrine, and tipped (except on the middle pair of rectrices) with brownish white, most broadly on the outer feathers; wings fuscous, the quills edged with citrine; coverts margined with the color of the back; lores and subocular streak, brownish white;

auriculars mouse gray; sides of neck like the back; chin and throat rather light smoke gray; breast and abdomen, dull strontian yellow, washed with yellowish citrine except on the middle of the abdomen; crissum dull barium yellow; lining of wing white, the axillars washed with barium yellow.

Measurements of type.—Wing, 66 mm.; tail 44.5; exposed culmen, 36.5; height of bill at base, 5; tarsus, 15; middle toe without claw, 10.

This race extends geographically from southern Tenasserim to the southern end of the Malay Peninsula. It differs from *Arachnothera longirostris melanchima* of eastern Sumatra in its lighter, more yellowish (less greenish) upper parts, and in the more golden hue of the yellow of the under surface.

Arachnothera longirostris heliocrita, subsp. nov.

Subspecific characters.—Resembling *Arachnothera longirostris antelia,* from the Malay Peninsula, but with bill smaller; upper parts darker, duller, more grayish or brownish, the olive green areas more greenish (less yellowish) in tone; and yellow of posterior lower parts slightly lighter and somewhat less extensive.

Type.—Adult male, No. 170469, U. S. Nat. Mus.; Selitar, 9 miles from the town of Singapore, Singapore Island, Federated Malay States, May 17, 1899; Dr. W. L. Abbott.

Measurements of type.—Wing, 67 mm.; tail, 44.5; exposed culmen, 32.5; height of bill at base, 5; tarsus, 16; middle toe without claw, 10.

This race has been noted only on the island of Singapore. It may be distinguished from *Arachnothera longirostris melanchima,* of eastern Sumatra, by its shorter bill; duller, less greenish (more grayish or brownish) upper parts; and the somewhat paler, more golden (less greenish) tint of the yellow of the posterior lower surface.

Anthreptes malacensis heliolusius, subsp. nov.

Subspecific characters.—Similar to *Anthreptes malacensis wiglesworthi,* from Sulu Island, but much larger.

Description.—Type, adult male, No. 201279, U. S. Nat. Mus.; Basilan Island, Philippine Islands, January 31, 1906; Dr. E. A. Mearns. Pileum, cervix, back, and sides of neck, iridescent metallic bottle green with some purplish reflections; rump and upper tail-coverts, metallic royal purple; tail fuscous black, the middle feathers more blackish, and with metallic purple sheen, all the rectrices edged with metallic purple and metallic bottle green; wings fuscous black, with the quills edged with orange citrine; middle coverts, edges of greater coverts, and the scapulars, chestnut; lesser coverts metallic royal purple; sides of head citrine, the upper part of these narrowly burnt sienna; chin, throat, and jugulum, tawny, bordered laterally with burnt sienna; breast deep wax yellow; abdomen light dull strontian yellow; crissum olive yellow; sides and flanks, light yellowish olive; lining of wing pale grayish brown, washed with citrine.

Measurements of type.—Wing, 68 mm.; tail, 44; exposed culmen, 16; tarsus, 17; middle toe without claw, 10.5.

This form is intermediate between *Anthreptes malacensis wiglesworthi* and *Anthreptes malacensis chlorigaster.* The female is similar to the female of *Anthreptes malacensis bornensis* Riley, but is of a darker, more bronzy green above, and is much duller, more olivaceous below.

Anthreptes malacensis heliocalus, subsp. nov.

Subspecific characters.—Similar to *Anthreptes malacensis heliolusius,* from Basilan Island, but tail and exposed culmen longer; male somewhat brighter and of a more golden yellowish below; female less bronzy above, particularly on rump, and with the golden yellow of the middle of abdomen brighter.

Type.—Adult male, No. 113786, U. S. Nat. Mus.; Great Sanghir Island, Sanghir Islands, June 30, 1886; Dr. Platen.

Measurements of type.—Wing, 71 mm.; tail, 48; exposed culmen, 18; tarsus, 17.5; middle toe without claw, 11.

Anthreptes simplex simplicior, subsp. nov.

Subspecific characters.—Similar to *Anthrepetes simplex simplex,* from Sumatra, but with lower parts, particularly the breast, sides, and flanks, much paler, more grayish (less greenish); and upper surface less golden (more greenish).

Description.—Type, adult male, No. 178268, U. S. Nat. Mus.; Central Borneo, 1899; Dr. A. W. Nieuwenhuis; original number 596. Forehead metallic dark green; upper parts dark citrine, slightly washed on the occiput with dark gray; tail citrine, duller terminally, the shafts of the feathers fuscous; wings fuscous, the edgings of the quills citrine, their superior coverts edged with dark citrine; auriculars mouse gray; sides of neck like the back; chin and throat buffy grayish white; rest of the lower parts light grayish olive, washed with dull yellowish, except the middle of the abdomen and the crissum, which are dull grayish reed yellow; lining of wing brownish white, the edge of wing more brownish and mixed with the color of the crissum.

Measurements of type.—Wing, 63 mm.; tail, 52; exposed culmen, 14; tarsus, 14.5; middle toe without claw, 9.

This well-differentiated race is apparently confined to Borneo.

Chalcostetha calcostetha heliomarpta, subsp. nov.

Subspecific characters.—Similar to *Chalcostetha calcostetha calcostetha,*[1] from Java, but with bill averaging longer; in the female, with upper parts, throat, jugulum, and abdomen paler, and whitish tips on the rectrices larger.

Description.—Type, adult female, No. 179390, U. S. Nat. Mus.; Simalur Island, western Sumatra, December 1, 1901; Dr. W. L. Abbott. Pileum between neutral gray and mouse gray; remainder of upper parts rather greenish deep olive, the middle portion of the upper tail-coverts dark brown; tail brownish black, the middle feathers and the outer webs of the others with a metallic bluish green sheen, and all but the middle pair broadly tipped with white; wings fuscous, their quills and coverts, excepting the lesser series, edged externally with citrine, the lesser coverts with the green of the back; sides of head brownish gray; sides of neck like the back; chin and throat brownish white; jugulum olive buff, washed with yellowish; middle of breast, together with the upper abdomen, between wax yellow and citrine yellow; lower abdomen primrose yellow; sides and flanks, dull olive buff, washed with pale yellow; crissum grayish white, washed slightly with pale yellow; lining of wing white, washed with pale yellow; edge of wing pale colonial buff.

[1] *N[ectarinia]. calcostetha* Jardine, Nat. Hist. Nectariniadae, 1843, p. 263 ("E. Ind. Islands.") Since this, the earliest name for this species, the *Chalcostetha insignis* of most authors, has not, in "E. Ind. Islands," a type locality definite enough for modern nomenclatural purposes, we designate Java as the type locality.

Measurements of type.—Wing, 57.5 mm.; tail, 45.5; exposed culmen, 19; tarsus, 14.5; middle toe without claw, 10.

So far as known, this race is confined to the island of Simalur. It is distinguishable from *Chalcostetha calcostetha pagicola* by its somewhat larger size, and, in the female, by lighter throat and darker abdomen.

Cinnyris ornata heliobleta, subsp, nov.

Subspecific characters.—Similar to *Cinnyris ornata*[2] *microleuca* from Pulo Taya, off southeastern Sumatra, but somewhat smaller; the male with upper surface darker, more greenish (less golden); yellow of posterior lower surface paler, more greenish (less golden), and flanks more greenish; the female above less golden in hue, and below paler, less golden, posteriorly.

Description.—Type, adult male, No. 175122, U. S. Nat. Mus.; Tanjong Dungun, Trengganu, Federated Malay States, September 21, 1900; Dr. W. L. Abbott. Upper parts dark citrine; tail brownish black, the three outer rectrices tipped with dull white, most broadly on the outermost; wings fuscous, the quills and all the coverts, except the primary series, narrowly margined externally with dark citrine; lores of the same color as the crown; center of chin, of throat, and of jugulum, raisin black; sides of chin, of throat, and of jugulum, together with the anterior part of the cheeks, metallic indigo blue; remainder of the sides of head, and the sides of neck, dark citrine; a narrow, somewhat broken, line across the breast at the posterior edge of the raisin black jugulum, prouts brown; pectoral tufts cadmium yellow; breast and abdomen, strontian yellow, the crissum paler; sides and flanks, wax yellow, washed with olivaceous; lining of wing white, washed with barium yellow; bill and feet black.

Measurements of type.—Wing, 51 mm.; tail, 35; exposed culmen, 17; tarsus, 13.5; middle toe without claw, 8.5.

Cinnyris ornata proselia, subsp. nov.

Subspecific characters.—Resembling *Cinnyris ornata heliobleta*, from the Federated Malay States, but somewhat smaller; male with upper parts darker, more golden olive, and yellow of posterior lower parts darker, more golden; female darker, more golden (less grayish) above, and darker, more golden posteriorly below.

Type.—Adult male, No. 178889, U. S. Nat. Mus.; Car Nicobar Island, Nicobar Islands, January 21, 1901; Dr. W. L. Abbott.

Measurements of type.—Wing, 49 mm.; tail, 34.5; exposed culmen, 16.5; tarsus, 14.5; middle toe without claw, 8.5.

This form is apparently confined to the island of Car Nicobar. It differs from *Cinnyris ornata klossi* (Richmond), from the other Nicobar Islands, in its smaller size; also, in the male, in much less golden (more grayish) upper surface, and rather lighter posterior lower parts; and, in the female, in the less golden hue of the upper parts, and lighter, less golden tint of the yellow of the posterior lower surface. It is, of course, readily distinguishable from *Cinnyris ornata blanfordi* (Baker)[3] by its much smaller bill.

[2] For the change of the name of this species from *Cinnyris pectoralis* to *Cinnyris ornata*, *cf.* Oberholser, Smithson. Misc. Coll., LX, No. 7, October 26, 1912, p. 18, footnote.

[3] *Cyrtostomus pectoralis blanfordi* Baker, Bull. Brit. Ornith. Club, XLI, No. CCLVI, January 27, 1921, p. 71 ("Kondol Is., Nicobars").

Mention, in passing, might be made of the fact that *Cinnyris ornata klossi* Richmond[4] is apparently a recognizable race, differing in both sexes from *Cinnyris ornata heliobleta*, of the Malay Peninsula in more golden (less grayish) upper parts, and darker more golden lower surface.

Cinnyris ornata heliomanis, subsp. nov.

Subspecific characters.—Similar to *Cinnyris ornata ornata*,[5] from Java, but in the male averaging more grayish (less golden) above, and slightly paler on posterior lower parts; in the female, with a more golden tinge to the olive of the upper surface, and with more deeply colored and more golden-hued posterior under surface.

Type.—Adult male, No. 182683, U. S. Nat. Mus.; Salintukan, eastern Borneo, March 13, 1913; H. C. Raven.

Measurements of type.—Wing, 48.5 mm.; tail, 32.5; exposed culmen, 16; tarsus, 13; middle toe without claw, 8.

Cinnyris ornata heliozeteta, subsp. nov.

Subspecific characters.—Similar to *Cinnyris ornata heliomanis*, from Borneo, but much larger; in the male, with upper surface more golden (less greenish), and posterior lower parts of a deeper, more golden yellow.

Type.—Adult male, No. 180616, U. S. Nat. Mus.; Tanjong Rengsam, Banka Island, southeastern Sumatra, May 21, 1904; Dr. W. L. Abbott.

Measurements of type.—Wing, 55 mm.; tail, 37; exposed culmen, 17; tarsus, 13; middle toe without claw, 10.

Aethopyga siparaja heliotis, subsp. nov.

Subspecific characters.—Similar to *Aethopyga siparaja cara*, from Tenasserim, but larger, and tail more greenish.

Description.—Type, adult male, No. 173263, U. S. Nat. Mus.; Domel Island, Mergui Archipelago, February 23, 1900; Dr. W. L. Abbott. Forehead and fore part of crown, metallic invisible green; lores black; sides of head and of neck, together with occiput, cervix, scapulars, upper back, and lesser wing-coverts, between carmine and nopal red; lower back brownish slate; rump between lemon chrome and light cadmium; upper tail-coverts metallic diamine green, the middle rectrices dull metallic purple, margined with metallic diamine green; rest of tail brownish black, margined externally with metallic purple; wings dark hair brown, the primaries, secondaries, greater and middle coverts, narrowly margined with dark citrine; chin, throat, and jugulum, between scarlet red and nopal red; a long submalar streak metallic prussian blue; posterior lower parts rather light neutral gray; middle of breast dark brownish, the flanks slightly washed with olivaceous; lining of wing dull white; edge of wing hair brown, slightly washed with dull red.

Measurements of type.—Wing, 55.5 mm.; tail, 48.5; exposed culmen, 16; tarsus, 14; middle toe without claw, 13.5.

Aethopyga siparaja heliophiletica, subsp. nov.

Subspecific characters.—Similar to *Aethopyga siparaja siparaja*, from Sumatra, but larger; and with less extensively blackish posterior lower parts.

[4] Proc. U. S. Nat. Mus., XXV, September 17, 1902, p. 297 ("Great Nicobar" [Island, Nicobar Islands]).

[5] Type locality, Java.

Type.—Adult male, No. 179405, U. S. Nat. Mus.; Pulo Bangkaru, Banjak Islands, Barussan Islands, western Sumatra, January 18, 1902; Dr. W. L. Abbott.

Measurements of type.—Wing, 51.5 mm.; tail, 45; exposed culmen, 15.5; tarsus, 13.3; middle toe without claw, 13.3.

This race is sufficiently different from the four other subspecies found on the various islands of the Barussan chain to be worthy of recognition by name. From *Aethopyga siparaja niasensis*, of Nias Island, it may be distinguished as from *Aethopyga siparaja siparaja;* from *Aethopyga siparaja tinoptila*, of Simalur Island, by somewhat larger size, less extensively blackish, and less purely grayish (more olivaceous) posterior lower parts; and paler anterior upper and lower parts.

Aethopyga siparaja heliogona, subsp. nov.

Subspecific characters.—Similar to *Aethopyga siparaja eupogon* Cabanis, from Borneo, but smaller, and male with more extensively blackish, and less olivaceous (more purely grayish) posterior lower parts.

Type.—Adult male, No. 219086, U. S. Nat. Mus.; Depok, Java, March 29, 1909; William Palmer.

Measurements of type.—Wing, 49.5 mm.; tail, 41; exposed culmen, 14.5; tarsus, 13.5; middle toe without claw, 13.5.

With the addition of the above described races, the forms of *Aethopyga siparaja* now apparently recognizable are as follows:

1.—*Aethopyga siparaja siparaja* (Raffles). Sumatra to southern Malay Peninsula.

2.—*Aethopyga siparaja tinoptila* Oberholser. Pulo Siumat and Simalur Island, Barussan Islands, western Sumatra.

3.—*Aethopyga siparaja melanetra* Oberholser. Pulo Lasia and Pulo Babi, Barussan Islands.

4.—*Aethopyga siparaja heliophiletica* Oberholser. Banjak Islands, Barussan Islands.

5.—*Aethopyga siparaja niasensis* Hartert. Nias Island, Barussan Islands.

6.—*Aethopyga siparaja photina* Oberholser. Pagi Islands, Barussan Islands.

7.—*Aethopyga siparaja heliogona* Oberholser. Java.

8.—*Aethopyga siparaja eupogon* Cabanis. Borneo.

9.—*Aethopyga siparaja ochropyrrha* Oberholser. Anamba Islands.

10.—*Aethopyga siparaja lathami* (Jardine).[6] Central Malay Peninsula, from about 10° north latitude to about 5° north latitude.

11.—*Aethopyga siparaja heliotis* Oberholser. Mergui Archipelago.

12.—*Aethopyga siparaja nicobarica* Hume. Nicobar Islands.

13.—*Aethopyga siparaja cara* Hume. Tenasserim and Siam.

14.—*Aethopyga siparaja viridicauda* Rothschild. Shan States.

15.—*Aethopyga siparaja andersoni* Oates. Burma.

16.—*Aethopyga siparaja seheriae* (Tickell). Bengal to Assam.

17.—*Aethopyga siparaja miles* (Hodgson). Nepal.

18.—*Aethopyga siparaja goalpariensis* (Royle). Northwestern Himalaya.

[6] *Nectarinia Lathami* Jardine, Nat. Hist. Nectariniadae, 1843, p. 233 ("some part of Continental India"). This was described from a specimen the exact locality of which is unknown, but the characters fit the bird from the Central Malay Peninsula. We therefore designate the Malay Penisula at 7° north latitude as the type locality.

MINERALOGY.[1]—Argentojarosite, *a new silver mineral.* (Preliminary note.) WALDEMAR T. SCHALLER, Geological Survey.

The name argentojarosite is given to a new silver mineral from the Titanic Standard mine at Dividend, Utah. It forms small hexagonal scales of a yellow to brown color, and optically is uniaxial, negative. The mineral closely resembles jarosite, and in fact has been mistaken for it. In composition the new mineral conforms to the general formula of the minerals of the jarosite group and the mean of several analyses shows that its composition is about as follows: Ag_2O, 18 per cent; Fe_2O_3, 43 per cent; SO_3, 28 per cent; H_2O, 10 per cent. A little K_2O is present, also some PbO. This composition yields the formula: $Ag_2O \cdot 3Fe_2O_3 \cdot 4SO_3 \cdot 6H_2O$.

The mineral apparently is sufficiently abundant to be mined as an ore. It is the first silver mineral recorded containing oxygen. A full description of argentojarosite is in preparation.

[1] Received May 16, 1923.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY OF WASHINGTON

645TH MEETING

The 645th regular meeting was held in the lecture room of the Cosmos Club Jan. 6, 1923, at 8.05 p.m., with President HITCHCOCK in the chair and 75 persons present.

The report of the treasurer, F. C. LINCOLN, was read and accepted. It showed a balance of $5.02 in the general fund and $840 in the publication fund.

Dr. A. WETMORE, for the auditing committee, reported that the books of the treasurer had been audited and found correct. His report was accepted.

The President announced the membership of the Committee on Communications as follows: E. A. GOLDMAN, Chairman, C. E. CHAMBLISS, H. E. EWING, W. R. MAXON, H. C. OBERHOLSER, S. A. ROHWER. He also announced the membership of the Committee on Zoological Nomenclature as follows: G. S. MILLER, Jr., Chairman, P. BARTSCH, S. A. ROHWER.

Short notes.—Major E. A. GOLDMAN mentioned the symposium on geographical distribution at the recent A. A. A. S. meeting in Cambridge, referring especially to a paper by C. T. BRUES on *Peripatus* and its allies in the southern hemisphere.

The regular program was as follows:

E. J. REINHARD: *Notes on the life history and habits of the solitary wasp, Philanthus gibbosus* (illustrated by lantern slides). The nesting and other habits of this wasp were described and illustrated by colored slides. The paper will appear in full in the Smithsonian Report.

VERNON BAILEY: *Beaver habits and beaver farming* (illustrated by lantern slides). The habits of beavers were discussed on the basis of the speaker's experience in various parts of the country, and illustrated by colored slides. The duration of beaver dams after abandonment, sometimes reaching a century or more, was emphasized. The importance of beaver farming to supply the demand for furs was also considered.

S. F. BLAKE, *Recording Secretary.*

646TH MEETING

The 646th regular meeting was held in the lecture room of the Cosmos Club, Jan. 20, 1923, at 8:05 p.m., with President HITCHCOCK in the chair and 83 persons present.

Dr. AFRANIO DO AMARAL, of the Museum of Comparative Zoology, Cambridge, Mass., was elected to membership.

The President announced an invitation extended to the Society by the Regents and Secretary of the Smithsonian Institution to a meeting in Commemoration of the centenary of the birth of Spencer Fullerton Baird, to be held in the auditorium of the National Museum, Saturday evening, February 3, the acceptance of which was voted.

Dr. L. O. HOWARD described an interesting new case of *phoresie* in the Belgian Congo, between a proctotrypid parasite and a Coreid bug. The female parent is carried about on the head of the female bug and when the latter deposits her eggs, the parasite instantly places her egg in the egg of

the bug. If the parasite finds herself on the head of a male bug, she jumps to the female bug when the sexes couple. This interesting observation was recently made by an Entomologist in the Belgian Congo, Lieut. J. Ghesquière.

Miss P. L. Boone directed attention to the early flowering of trailing arbutus, pansy violets, golden club, saxifrage, and skunk cabbage near Hyattsville, Md.

Horace M. Albright, Superintendent, Yellowstone National Park: *Protecting native wild life in Yellowstone National Park* (illustrated by lantern slides and moving pictures). Park scenery and conditions and the larger animals were described and illustrated by still and moving pictures. The desirability of adding to Yellowstone National Park the region about the sources of the Yellowstone River and Teton Range was advocated. The larger game animals were said to be wintering in excellent condition. The number of buffaloes in the introduced herd was reported to be about 578, in the wild herd about 150. The antelope numbered about 350. Of several hundred mountain sheep occurring in the Park one hundred and forty-two had recently been seen. The sheep were reported to have entirely recovered from scab with which Park animals became infested a few years ago.

Frank R. Lillie, National Research Council: *The problem of the sex hormones*. The rôle of the hormones in the differentiation of sex was discussed. The precision with which hormones operate was stressed, sex being regarded as inherited like other characters, and the action of sex hormones regarded as intensifying the zygotic factors of the same sign and vice versa. Sex is determined at the time of fertilization in accordance with the chromosome complex, and not in accordance with environmental factors. Lipschutz's view that an embryo is essentially asexual until its sex is impressed upon it by hormones of the male or female type was shown to be untenable. The speaker also expressed the view that the effects of sex hormones are strictly limited in the case of the free-martin in cattle, though it is possible that they may vary in different species. The paper was discussed by A. A. Doolittle. The principal data are included in a paper to be published in the Biological Bulletin for February, 1923.

E. A. Goldman, *Recording Secretary, protem.*

647th meeting

The 647th meeting was held jointly with the Washington Academy of Sciences and affiliated societies in the auditorium of the National Museum February 3, 1923, in commemoration of the centenary of the birth of Spencer F. Baird.

648th meeting

The 648th regular meeting was held in the lecture room of the Cosmos Club, February 17, 1923, at 8.10 p.m., with President Hitchcock in the chair and 91 persons present. Mr. R. C. Shannon was elected to membership.

The President announced the appointment of E. A. Chapin and H. C. Oberholser as additional members of the Committee on Zoological Nomenclature.

Mr. M. B. Waite directed attention to an article in the Geographical Journal for January, 1923, describing an ascent of Mount Kilimanjaro. Interesting features were mentioned including the perfect volcanic cone with an ice cap inside of crater, and the distribution of plants in belts at different altitudes.

Dr. L. O. HOWARD stated that on Tuesday, last, he addressed a meeting of a new biological society at Riverton, N. J., the Japanese Beetle Club. The aim of this society is to consider many questions in biology, the only restriction being that nothing shall be said about the Japanese beetle.

Dr. T. S. PALMER referred to the death, just announced in the press, of B. E. FERNOW, former Forester of the United States at 72 years of age, and recalled his active interest in the affairs of the Biological Society.

H. L. SHANTZ: *Plant and animal life in Africa.* The vegetation of Africa varies from the absolute desert to luxuriant tropical rain forest. In a very general way the vegetation may be arranged in almost concentric bands around the tropical rain forest of the Congo and Guinea Coast. We pass outward from this tropical forest through series of grasslands and savannas and dry forest to the desert proper. In East Africa the occurrence of highland modifies the vegetation and gives rise to a temperate grassland and temperate forest. Lying beyond the desert in both the north and the south is a brushland of the Mediterranean or Californian type. In a general way the fauna of Africa may be correlated with vegetation. The greatest herds of wild game, especially the great wealth of herbivora, and even carnivora, which feed upon the heribivora, are found in the same desert grasslands and the rather luxuriant savanna adjacent. In the dense tropical forests many of the herbivora are entirely lacking. The elephant ranges from the semidesert to the dense tropical forest, and from sea level to timber line. Distribution of many of the other animal types is restricted and can be correlated very closely with vegetation types. Probably the sharpest faunal line is that between tropical rain forest and high grass savanna which surrounds it.

H. S. BERNTON, M.D.: *Biological aspects of hay fever.* A brief outline of the historical features of the disease was presented. The fact that the pollens of wind pollinated plants were responsible for symptoms was emphasized and the phenomena of "group reaction" was discussed. Mention was made of the hereditary tendency of the disease which follows the Mendelian law. The clinical features were enumerated and the theories underlying the mechanism of the disease were also presented. The modern treatment is that of active immunization, wherein a solution of pollen protein is administered subcutaneously in gradually increasing doses. Twenty per cent are entirely relieved of symptoms and ten per cent are not benefited. The opinion was expressed that the imperfect method of extraction and especially the method of preserving the antigenic content of the pollen solutions might account for some failures in the treatment. A preliminary report of the results of feeding experiments with powdered ragweed plant was also given.

E. A. GOLDMAN, *Recording Secretary, pro tem.*

649TH MEETING

The 649th regular meeting was held in the lecture room of the Cosmos Club March 3, 1923, at 8 p.m., with President HITCHCOCK in the chair and 54 members present. Miss ANNA E. JENKINS, Bureau of Plant Industry, was elected to membership.

Under *Short Notes,* Dr. R. W. SHUFELDT read a letter and showed literature relating to the work of the British Royal Society for the Protection of Birds. He also exhibited a new work "Australian Nature Studies," by J. A. LEACH of Melbourne.

Dr. T. S. PALMER mentioned that Prince MAXIMILIAN VON NEUWIED began his exploring trip up the Missouri River on March 1, 1833, ninety years ago, and gave a short account of his life and work.

Dr. Hugh M. Smith gave some notes on the flowering of *Cercis*.

F. V. Coville: *The effect of aluminum sulphate on rhododendron seedlings.* Rhododendrons do not thrive in ordinary fertile garden or greenhouse soil, but they grow with great luxuriance in sand mixed with peat, with rotting wood, or with half-rotted leaves. Although both these types of soil contain an abundance of plant food, the rhododendrons thrive in the peat and sand mixture because its chemical reaction is acid, and they die in the ordinary fertile garden soil because its reaction is neutral or alkaline. Experiments begun in March, 1921, show that the application of aluminum sulphate to ordinary fertile garden or greenhouse soil changes its reaction from neutral or alkaline to acid, and that after this treatment rhododendrons will thrive in it almost as well as in a natural acid soil of peat and sand. The paper will be published in full as Bulletin 1 of the newly formed American Horticultural Society, Washington, D. C.

Perley Spaulding: *The biology of* Pinus strobus. The speaker gave notes on *Pinus strobus* as seen in Europe only. It is essentially an ornamental except for small areas of forest in Switzerland, eastern France and Germany. The blister rust caused by *Cronartium ribicola* is its worst enemy and is exterminating the species in Europe, as reforestation with it is discontinued. Where the blister rust has not attacked it, its timber production is of high value. Rabbits prevent its reproduction naturally in Great Britain, by eating the young seedlings. Jays and squirrels feed on the seeds, limiting reproduction. Calcareous soils produce yellow-foliaged, sickly trees. The species is very hardy and quite free from snow breakage. *Fomes annosus* attacks it rarely. *Peziza calycina* occasionally attacks it. *Armillaria mellea* is a serious enemy especially on land previously occupied by hard wood species.

J. M. Aldrich: *The Canadian life zone as indicated by insect distribution.* Of the three northern life zones recognized by Merriam and Bailey, the Canadian is the richest. It contains thousands of species of insects, no order being better represented than the Diptera. From the beginning it has proved difficult to fix the limits of the Canadian by any satisfactory list of typical plants or animals, the species generally shading off into the Transition or continuing up into the Hudsonian. The speaker found this difficulty also in the insects, citing numerous cases of species spreading beyond the true Canadian limits. A number of species of Diptera were cited which confirm in their appearance at points remote from each other the existence of a real life zone, though with vague boundaries. The scavenger flies were used to illustrate the subject further.

H. C. Oberholser: *Notes on birds of the District of Columbia.* The speaker mentioned a number of the rarer birds of the District of Columbia, illustrating his talk by colored lantern slides of the species discussed.

650th meeting

The 650th meeting was held in the auditorium of the Interior building March 14, 1923, at 8 p.m., jointly with Washington Academy of Sciences, the Geological Society, and the Botanical Society. The meeting was devoted to a discussion of the fossil swamp deposit at the Walker Hotel site.

The speakers were C. K. Wentworth, E. Brown, E. W. Berry, Albert Mann, and Laurence La Forge.

651st meeting

The 651st meeting of the Biological Society was held in the lecture room of the Cosmos Club, March 17, 1923, at 8 p.m., with President Hitchcock

in the chair and 88 persons present. W. H. Cheesman and Charles P. Hartley were elected to the Society.

Under *Short Notes*, Dr. R. W. Shufeldt mentioned that "Nature Magazine," a Washington publication which was started in January, 1923, already has 11,000 subscribers.

Mr. Vernon Bailey spoke of the travels of Prince Maximilian in North America and his work among the Mandan Indians.

J. C. Merriam: *The cats of Rancho La Brea* (lantern). In the fauna of the Pleistocene asphalt beds of Rancho La Brea carnivorous mammals and birds make up a very large percentage of the great accumulation of remains. This is due in considerable measure to the attraction of flesh-eating and carrion-eating animals to the asphalt beds by the struggles of animals recently entrapped or by the carcasses of those partly buried in the brea. The body of one animal may have served as a lure to many carnivores, each of which in turn possibly attracted many others. In some parts of the deposits the carnivores have greatly overbalanced in number the total accumulation of remains from all other groups. Although the fossil wolves of Rancho La Brea are individually the most numerous of the carnivorous animals, the relative abundance of cats is almost unbelievable. Of the great sabre-tooth tiger many more than one thousand specimens are known in the several available collections. The sabre-tooth is not only the most numerous of the forms found but gives a representation of this group greater than all the other collections of the world combined. The great lion-like form, *Felis atrox*, is less abundant than the sabre-tooth but is known by something more than fifty specimens. This is the largest of all the cats. It is fortunately known by material which makes possible the study of the entire skeleton in perfectly preserved condition. Other felines include one or more pumas and at least one species of wild cat. This paper was discussed by Messrs. Bailey, Howard and Shufeldt.

F. A. McClure, Canton Christian College: *Observations of a plant collector on the island of Hainan* (lantern). In the fall of 1921 and the spring of 1922 the speaker made two expeditions to the island. On these trips he increased the known flora of Hainan from 350 to about 1350 species (of which over 75 were new to science). He was also successful in making the first ascent to the summit of the highest peak of the Five Finger Mountains, altitude 7,300 feet. The topography and native tribes of the island were described and illustrated by numerous colored lantern slides. The following new plants worthy of special notice for economic reasons were mentioned: *Taractogenos hainanensis*, *Ficus palmatiloba*, and *Schizostachyum hainanense*.

S. F. Blake, *Recording Secretary.*

BOTANICAL SOCIETY

163d meeting

The 163d meeting of the Botanical Society was held at the Cosmos Club at 8 p.m. Tuesday, December 5, 1922, with Dr. L. C. Corbett in the chair.

The following members were elected: Wilbur Brotherton, Lewis T. Leonard, Culross Peattie, Dr. Robert. D. Rands, and Dr. J. R. Schramm.

Brief Notes and Reviews of Literature: Dr. Hitchcock presented the book, *The mind in the making*, by James Harvey Robinson. Mr. Waite showed acorns of the bur oak, *Quercus macrocarpa*. This oak is a native of the

Mississippi Valley. He called attention to the large size and enormous spread of the branches of this oak. One of the finest trees on the Department of Agriculture grounds in Washington is a planted bur oak. Dr. BARTSCH called attention to the fact that there is a large bur oak on the Hygienic Laboratory grounds. Prof. CORBETT called attention to the fact that this oak had pushed its way up into the dry northwest. He became acquainted with it in South Dakota.

Program: Dr. ROBERT D. RANDS: *Botanic gardens and plant industries of Java and Sumatra* (illustrated). Dr. RANDS traced briefly the early history of the famous government botanical garden at Buitenzorg, Java, and its importance in the establishment and development of the great European plantation industries of these islands. In the approximate order of their importance, the principal industries are sugar, rubber, tobacco, coconut products, coffee, tea, cacao, cinchona, kapoc, palm oil, and sisal.

In more recent years the planters' associations have established their own experiment stations, which at present number ten; three are devoted primarily to the study of tobacco, four to rubber, and one each to sugar, tea and cinchona. Despite the great importance of these "European cultures," the area they occupy is much smaller than that tilled by the natives. The latter, who in Java exceed thirty millions in number, are engaged largely in the cultivation of rice, maize, cassava, sweet potatoes, and other food crops.

Since 1905 the botanical gardens have formed a subdivision of the Department of Agriculture, which was established at that time. The main one, located at an elevation of 900 feet at Buitenzorg, was founded in 1814; in number of species and development it is probably the finest in the tropics. Within its grounds is the splendidly equipped Treub laboratory for visiting botanists, maintained by the government free of charge. There are in addition a large Cultuurtuin, or experiment station, and a selection station for annual crops. The acclimatization garden at Tjibodas, at an elevation of 4500 feet, and the vegetational zones of the magnificent virgin jungle on Mt. Gedeh, extending from the upper margin of the garden to the summit crater of the mountain at 10,000 feet, were described and illustrated. At Tjibodas, the government maintains a laboratory and lodging quarters for visiting biologists. In closing Dr. RANDS referred briefly to his studies of the disease of rubber and cinnamon in which he was engaged for three years as botanist in the Dutch Colonial Service at Buitenzorg.

J. H. BEATTIE: *Sweet potato nomenclature* (illustrated). From a utilitarian standpoint, the sweet potato is perhaps the most important member of the well known Morning Glory family. In the Torrid Zone and in the warmer parts of the Temperate Zones the plant is a perennial, but in the United States, where it has attained its greatest economic importance, it is treated as an annual.

Evidence exists that the sweet potato originated in the Western Hemisphere. De Candolle supports this view, but admits that there are important arguments in favor of its origin being Asiatic. Ovildo, writing in 1526, mentions the sweet potato as being freely cultivated and eaten by natives of Santo Domingo. Columbus, in presenting Queen Isabella with the choice products of the new world, did not fail to include the sweet potato. Chinese works written during the second or third century of our era mention other species of Convolvulaceae, hence we are compelled to believe that the plant has been cultivated for many centuries, and that its exact origin is in doubt. Its distribution is so general that it enters into the diet of a large portion of the people inhabiting the Torrid and Temperate Zones.

The sweet potato is second in importance of our vegetable crops, but previous to a few years ago it was looked upon as one of the most hazardous crops, as it was very difficult to keep, as storage methods for other vegetables were found to be unsuited to this crop. Satisfactory storage methods and storage houses have been devised, and it is now an easy matter to make the vegetable available for practically the entire year. Over 3000 so-called Government type storage houses with a capacity of about 12,000,000 bushels are now in use. Experimental work extending over a period of several years and summarized in Departmental Bulletin 1063, *Sweet potato storage studies*, shows that standard varieties of sweet potatoes can be kept in this type of house for periods of from 5 to 6 months with losses of less than 1 per cent from decay.

Sweet potato varieties and sweet potato nomenclature have been, and are, badly confused. About 1905, F. J. Tyler, worked out the basis of a key for the identification of sweet potato varieties based on:

I. Leaves deeply lobed or parted.
   1. Leaves with purple stain at base of leaf blade.
   2. Leaves without purple stain at base of leaf blade.

II. Leaves not deeply lobed or parted.
   1. Leaves with purple stain at base of leaf blade.
   2. Leaves without purple stain at base of leaf blade.

Other characters taken into account in connection with these main distinguishing characteristics were, stems purple or green, length of petioles, length of vines, size, shape and color of potatoes and color of flesh. The key is based mainly on botanical characters. For a full discussion reference is made to Departmental Bulletin 1921, entitled *Group classification and varietal description of American varieties of sweet potatoes.* Through the use of this key some 40 varieties have been recognized as such.

Adjournment was followed by a social hour.

Roy G. Pierce, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

At the Annual Meeting of the National Academy of Sciences held in Washington on April 23, 24, and 25, the following officers were elected for the ensuing year: *President*, A. A. Michelson; *Vice-President*, J. C. Merriam; *Foreign Secretary*, R. A. Millikan; *Home Secretary*, David White; *Treasurer*, F. L. Ransome.

The National Academy of Sciences elected to membership the following scientists: S. I. Bailey, Harvard Observatory; J. H. Breasted, University of Chicago; E. W. Brown, Yale University; C. H. Eigenmann, University of Indiana; Yandell Henderson, Yale University; M. A. Howe, New York Botanical Garden; Max Mason, University of Wisconsin; E. D. Merrill, Bureau of Science, Manila; E. L. Opie, Washington University, St. Louis; Leonhard Stejneger, U. S. National Museum; G. F. Swain, Harvard University; R. C. Tolman, California Institute of Technology; D. L. Webster, Stanford University; F. E. Wright, Geophysical Laboratory, Carnegie Institution of Washington; R. M. Yerkes, National Research Council.

G. P. Merrill, R. B. Moore, and T. W. Vaughan were elected to membership in the American Philosophical Society at the meeting on April 21.

At the meeting of the Bureau of Standards Physics Club, on Monday, May 7, Dr. P. D. FOOTE lectured on *The nucleus of the atom.*

Mr. M. AUROUSSEAU, petrologist at the Geophysical Laboratory, Carnegie Institution of Washington, resigned on May 15 to join the scientific staff of the American Geographical Society, New York City.

Mr. K. C. HEALD, geologist, of the U. S. Geological Survey, is on leave of absence for several months to give a course of lectures on petroleum geology at the University of Chicago.

Dr. EDWARD P. HYDE, who organized the Nela Research Laboratories in 1908, and who for the past few years has occupied the position of director of research of the National Lamp Works of the General Electric Company, has tendered his resignation to take effect June 30. Dr. Hyde, who has been active in scientific and technical affairs for a number of years, has decided to take a prolonged rest abroad.

Dr. HUGH M. SMITH, formerly commissioner of fisheries, has been appointed fisheries adviser of the Siamese government.

Dr. A. C. SPENCER has been granted leave of absence for a month from the U. S. Geological Survey to do professional work in Cuba.

④ JOURNAL

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SPECTROSCOPY.—*Regularities in the arc spectrum of iron.*[1] F. M. WALTERS, JR., Bureau of Standards.

According to the Bohr theory a particular line of the so-called arc spectrum of an element is emitted when the energy of a normal atom changes in a manner governed by quantum conditions. Thus a spectral line of frequency ν corresponds to an energy change of $h\nu = E_i - E_f$ where E_i and E_f are the initial and final states of the atom. A multitude of possible states or energy levels exists for each atom and different spectral lines result from different combinations of these. Further, the different sets of levels are usually polyfold, that is, each so-called state may really consist of two or more slightly different conditions of energy. Intercombinations of these multiple levels give rise to groups of spectral lines which increase in complexity as the multiplicity of the levels involved in their production increases. The frequency differences of the lines are proportional to the energy differences of the associated levels, and when one multiple set of levels enters into combination with two or more different sets, the corresponding groups of lines will repeat the wave number differences characterizing this set of levels. These repeated differences have been shown by interferometer measurements[2] to be strictly constant, and they are, therefore, a positive criterion for the analysis of spectra. In addition to the well-known spectral series and intercombinations consisting of singlets, doublets and triplets, more complex groups of lines were discovered by Popow[3] and very recently still more complicated groups have been found by Catalan[4] in the spectra of manganese and chromium and by Kiess[5] in the arc spectrum of molybdenum. For these complex groups Catalan coined the work "multiplets."

[1] Received May 23, 1923. Published by permission of the Director, Bureau of Standards. Communicated by Dr. W. F. Meggers.

[2] Bureau of Standards Scientific Papers, 329, 414 and 441.

[3] Annalen der Physik **45**: 147. 1914.

[4] Phil. Trans. A. **223**: 127. 1922, Fisica y Quimica 21 p. 84, 1923.

[5] Bureau of Standards Scientific Paper, in press.

The spectra of the chemical elements in the periodic table become more complex, in general, as the right-hand side of the table is approached and the difficulty of classification is correspondingly increased. Thus the spectra of the elements in the first two columns are almost completely classified, and typical series or groups of lines have been indentified for one or more elements in the remaining columns, except the 5th and 8th, for which no significant regularities have heretofore been detected. Of the metals in the eighth column, iron, although its spectrum contains more than 5000 lines, is nevertheless, the best adapted for study because of the following reasons. Since the iron arc was adopted as the source of secondary and tertiary standards of wave-lengths, more of its lines have been measured with high precision and the relative values of the wave-lengths are of first importance in testing the constancy of wave-number differences. Furthermore, the data on temperature classification and Zeeman effect which sometimes assist in detecting spectral regularities, are more extensive for the lines of iron than for any other element in the 8th column. In this preliminary report is presented a classification of about 200 of the stronger lines of the iron arc spectrum in twenty multiplets.

The wave-lengths and intensity and character designations given in Table 1 are taken from the observations of Burns.[6] Wave-lengths were converted to wave numbers (number of waves per centimeter) by the use of a table of reciprocals and corrected to vacuum by the table given by Meggers and Peters.[7] The temperature classification is that of King.[8] The notation for the Zeeman effect, measured by King[9], expresses the observed separations as fractions of the normal effect, the figures in parentheses refer to the parallel components, the others to the normal components.

In Table 1, the lines of each multiplet are given in the order of increasing wave-length. Each of these groups may be readily rearranged to bring in evidence the line structure and separations of the polyfold sets of levels involved in the multiplet. The first three multiplets are rewritten in this manner following Table 1, and will serve as examples.

[6] Lick Obs. Bull. No. 247, vol. 8, 1913.
[7] Bull. Bureau of Standards, **14**: 697, 1918.
[8] Astrophysical Jour. **37**: p. 239. 1913.
Astrophysical Jour. **56**: 351. 1922.
[9] Papers Mt. Wilson Solar Obs. Vol. 2, 1912.

TABLE I—MULTIPLETS IN THE ARC SPECTRUM OF IRON

λI. A.	INT.	νVAC.	TEMP. CLASS.	ZEEMAN PATTERN	LINE STRUCTURE AND SEPARATIONS
3824.444	6R	26140.19	IA	$\frac{(?)3}{2}$	2+3+3+3+1
3856.373	6R	25923.77	IA	$\frac{(0)3}{2}$	
3859.913	7R	25900.00	I	$\frac{(0)3}{2}$	415.96
3878.578	6R	25775.35	II	$\frac{(0)3}{2}$	288.10
3886.287	7R	25724.24	IB	$\frac{(0)3}{2}$	184.17
3895.659	5r	25662.35	IB	$\frac{(0)3}{2}$	89.92
3899.711	6r	25635.67	IB	$\frac{(0)3}{2}$	
3906.484	5r	25591.23	IB	$\frac{(0)3}{2}$	240.20
3920.261	6r	25501.31	IB	$\frac{(0)3}{2}$	199.53
3922.917	6R	25484.03	IB	$\frac{(0)3}{2}$	139.73
3927.925	6r	25451.45	IB	$\frac{(0)3}{2}$	71.12
3930.304	7R	25436.14	IB	$\frac{(0)3}{2}$	
2981.448	4r	33531.00	I		2+3+3+3+3
2983.571	4r	33507.13	I		
2994.434	6R	33385.54	I		415.96
3000.951	5r	33313.08	I		288.04
3007.284	4r	33242.94	I		184.13
3017.630	5r	33128.96	IA		89.95
3020.495	5r	33097.53	II		
3020.643	6r	33095.93	I		
3021.076	6R	33091.17	I		
3024.035	5r	33058.78	IA		411.20
3025.846	5r	33039.01	I		294.40
3037.392	5r	32913.43	I		145.40
3047.608	6r	32803.10	I		70.16
3059.090	5r	32679.98	I		
5208.610	4	19193.65	IV	$\frac{(?)3}{2}$	2+3+3+3+1
5215.195	4	19169.41	IV	$\frac{(?)3}{2}$	
5217.405	4	19161.28	V	$\frac{(?)3}{2}$	240.17

TABLE 1—*Continued*

NO.	λI. A.	INT.	νVAC.	TEMP. CLASS.	ZEEMAN PATTERN	LINE STRUCTURE AND SEPARATIONS
3	5229.84	2	19115.72	V	$\frac{(0)3}{2}$	199.52
	5253.479	2	19029.71			139.70
	5263.321	5	18994.15	V	$\frac{(0)3}{2}$	71.07
	5273.178	3	18958.64			
	5283.634	7	18921.12	IV	$\frac{(0)3}{2}$	284.33
	5302.315	5	18854.45	V	$\frac{(0)3}{2}$	272.56
	5324.196	6	18776.96	IV	$\frac{(0)3}{2}$	175.26
	5339.949	3	18721.57	V	$\frac{(0)3}{2}$	86.01
	5393.185	4	18536.78	IV	$\frac{(0)3}{2}$	
4	3057.451	5r	32697.50	II		3+3+3+2+1
	3067.250	5r	32593.04	II		
	3075.725	5r	32503.25	II		448.45
	3083.745	4r	32418.71	II		351.26
	3091.581	4r	32336.56	II		257.74
	3099.898	4r	32249.79	II		168.92
	3099.968	4r	32249.05	II		
	3100.305	4r	32245.56	II		344.00
	3100.668	4r	32241.78	II		261.52
	3116.632	5	32076.65	III		173.14
	3125.663	6	31983.99	III		86.77
	3134.109	5	31897.78	III		
5	3355.517	1	29793.13			3+3+3
	3356.332	1b	29785.88	IVA		448.48
	3359.496	3	29757.84	IIIA		351.24
			29535.23			257.77
	3396.386	1	29434.64			
	3404.301	2	29366.20	IIIA		476.52
	3410.905	1	29309.36			358.49
	3426.393	4	29176.87	IIIA		
	3452.279	4	28958.11	III		
6	3396.982	3	29429.48	IIIA		3+3+2
	3397.642	2	29423.76	IIIA		
	3401.523	4	29390.18	III		351.31
	3417.265	1	29254.81			257.68
	3426.994	2	29171.76	IIIA		168.99

TABLE 1—*Continued*

NO.	λI. A.	INT.	νVAC.	TEMP. CLASS.	ZEEMAN PATTERN	LINE STRUCTURE AND SEPARATIONS
6	3442.676	2	29038.87	IIIA		
	3446.966	1	29002.73			390.58
	3473.497	1	28781.22			252.04
7	3466.501	2	28839.29	IIIA		2+3+3
	3483.012	4	28702.58	IIIA		
	3513.822	5	28450.93	II		448.50
	3521.264	5r	28390.79	I		351.28
	3526.167	5	38351.32	II		257.77
	3558.522	5r	28093.55	II		
	3565.383	6R	28039.50	I		388.36
	3570.102	7R	28002.43	I		311.80
8	3540.715	2	28234.85	IIIA		1+2+3+3
	3554.121	4	28128.34	IIIA		
	3585.322	6r	27883.56	II		351.28
	3585.708	5	27880.57	II		257.72
	3586.989	6r	27870.61	II		168.91
	3608.860	6R	27701.70	I		
	3618.769	6R	27625.84	I		474.92
	3631.464	6R	27529.29	I		354.28
	3647.845	6R	27405.65	I		244.78
9	3687.458	6R	27111.27	I	$\frac{(0)3}{2}$	2+4+3+3+2
	3709.250	6r	26952.00	II	$\frac{(0)3}{2}$	448.49
	3727.622	6R	26819.15	II	$\frac{(?)3}{2}$	351.29
	3734.869	9R	26767.12	II	$\frac{(0)3}{2}$	257.73
	3743.356*	3r	26706.35	IA	$\frac{(2, 0)4, 2, 0}{4}$	168.90
	3749.487	8R	26662.76	II	$\frac{(0)4}{3}$	
	3758.234	7R	26600.71	II	$\frac{(0)5}{4}$	344.14
	3763.792	6R	26561.42	II	$\frac{(0)2}{2}$	289.24
	3767.194	6R	26537.43	II	Unaffected	218.44
	3887.880	6R	26392.53	II	$\frac{(2, 0)4, 2, 0}{2}$	144.92
	3795.004	6r	26342.98	II	complex	

* Given by Burns as a pair but measured three times as a reversed line.

TABLE 1—*Continued*

NO.	λI. A.	INT.	νVAC.	TEMP. CLASS.	ZEEMAN PATTERN	LINE STRUCTURE AND SEPARATIONS
9	3798.512	6r	26318.65	II	$\frac{(0)3}{2}$	
	3799.548	6r	26311.47	II	$\frac{(0)3}{2}$	
	3837.136	1	26053.74	IV		
10	3812.966	6r	26218.89	II		3+3+3+3+2
	3820.430	8R	26167.66	II	complex	448.50
	3825.886	8R	26130.35	II	complex	351.31
	3834.227	7R	26973.50	II	complex	257.73
	3840.443	6R	26031.30	II	$\frac{(1, 0)3, 2, 1}{2}$	168.93
	3850.820	5	25961.16	II	complex	
	3865.526	6r	25863.38	II	$\frac{(6)3, 0}{4}$	
	3872.506	6r	25815.77	II	$\frac{(2, ?)4, 3, 2, 1}{2}$	411.20
	3876.044	1	25792.20	III		294.46
	3878.024	6r	25779.05	II	$\frac{(2)4}{3}$	145.38
	3887.053	6r	25719.16	IB	$\frac{(1)3?}{2}$	70.16
	3898.013	4	25646.86	IB?	$\frac{(3)6?}{2}$	
	3917.185	5	25521.31	IB		
	3940.885	4	25367.84	IA?	(0)2	
11	4939.689	3	20238.55	IB	$\frac{(0)8}{5}$	2+3+3+3+2
	4994.133	3	20017.93	IB	$\frac{(0)3}{2}$	448.51
	5012.073	4	19946.28	IB	$\frac{(0)7}{5}$	351.30
	5041.079	3	19831.51	IB	$\frac{(0)4}{3}$	257.72
	5051.643	4	19790.04	IB	$\frac{(?)4}{3}$	168.92
	5079.742	3	19680.55	IB		
	5083.344	4	19666.61	IB	$\frac{(?)6}{5}$	292.27
	5107.454	3	19573.77	IB	$\frac{(?)2}{2}$	227.88
	5123.727	4	19511.63	IB	Unaffected	164.88
	5127.364	3	19497.77	IB	$\frac{(?)7}{4}$	106.78

TABLE 1—*Continued*

NO.	λI. A.	INT.	νVAC.	TEMP. CLASS.	ZEEMAN PATTERN	LINE STRUCTURE AND SEPARATIONS
11	5142.934	3	19438.75	IB	$\frac{(?)3,\ 0}{2}$	
	5150.845	4	19408.90	IB	$\frac{(?)8}{5}$	
	5151.916	3	19404.86	IB	?	
12	5269.538	10	18971.72	IB	$\frac{(0)6}{5\ ?}$	3+3+3+2+1
	5328.044	7	18763.41	IB	complex	448.51
	5371.496	7	18611.62	IB	complex	351.30
	5397.135	6	18523.21	IB		257.72
	5405.780	6	18493.59	IB	$\frac{(1,\ 0)4,\ 2}{4}$	168.92
	5429.701	6	18412.11	IB	complex	
	5434.527	6	18395.76	IB	unaffected	240.20
	5446.922	6	18353.90	IB	$\frac{(2,\ 1)4,\ 3,\ 2,\ 1}{2}$	199.50
	5455.617	6	18324.66	IB	$\frac{(6)3}{4}$	139.68
	5497.521	4	18184.98	IB	$\frac{(3,\ 0)6,\ 3,\ 0}{4}$	71.10
	5501.471	4	18171.92	IB	?	
	5506.785	4	18154.40	IB	?	
13	2501.14	3b	39969.72	II		2+3+3+3+1
	2510.843	6b	39815.25	II		
	2518.11	6b	39700.36	II		415.80
	2522.86	5r	39625.63	II		288.08
	2527.44	4r	39553.82	II		183.95
	2529.143	6b	39527.20			90.12
	2529.83	4	39516.46	III		
	2535.613	6	39426.34	III		344.00
	2540.97	6	39343.20	III		261.46
	2545.987	3	39265.71	III		173.21
	2549.616	6	39209.92	III		86.56
14	2719.037	7r	36766.84	II		3+3+3
	2720.910	7r	36741.55	II		
	2723.582	6r	36705.50	II		415.84
	2737.312	6r	36521.39	II		288.04
	2742.408	6r	36453.53	II		184.13
	2750.145	6r	36351.00	II		89.95
	2744.072	8	36431.44	II		
	2756.332	5	36269.38	I		390.57
	2772.112	6	36062.94	III		251.99

TABLE 1—*Continued*

NO.	λI. A.	INT.	νVAC.	TEMP. CLASS.	ZEEMAN PATTERN	LINE STRUCTURE AND SEPARATIONS
15	2912.161	8	34328.72	I		1+2+3+3+3
	2929.006	7	34131.31	I		415.90
	2936.903	7r	34039.53	I		288.12
	2941.343	8	33988.12	I		184.16
	2947.876	5r	33912.84	I		89.91
	2953.943	5r	33843.18	II		344.16
	2957.370	5r	33803.97	II		289.22
	2965.258	5r	33714.06	II		218.46
	2970.107	4r	33659.02	I		144.94
	2973.137	4r	33624.72	I		
	2973.236	4r	33623.60	I		
16	3649.308	3	27394.67	IA		1+2+3+3+3
	3679.915	5r	27166.82	IA		
	3683.056	4	27143.66	IA		415.92
	3705.567	6R	26978.76	I		288.08
	3707.828	3u	26962.43	I		184.11
	3719.938	8R	26874.53	I		89.91
	3722.565	6R	26855.57	IA		
	3733.319	6R	26778.22	IA		292.29
	3737.135	7R	26750.88	I		227.86
	3745.563	7R	26690.69	I		164.89
	3745.900	6R	26688.31	IA		106.76
	3748.264	6R	26671.45	I		
17	5569.631	5	17949.53	IV	complex	3+3+3+2+1
	5572.857	5	17939.15	IV	complex	292.22
	5576.106	4	17928.69	IV	unaffected	227.90
	5586.772	6	17894.46	IV	complex	164.90
	5602.965	3	17842.76	IV	$\frac{(6)\ 3,\ 0}{4}$	106.75
	5615.663	6	17802.37	IV	$\frac{(0)5}{4}$	
	5624.563	5	17774.23	IV	?	384.33
	5658.542	1	17667.50	.		272.54
	5658.836	4	17666.58	IV	?	175.28
	5709.395	3	17510.15	IV	?	85.93
	5712.150	2	17501.71			
	5784.69	1	17282.23			
18	4147.675	4	24103.11	IB	?	1+2+3
	4202.032	7r	23791.33	II	complex	584.72
	4250.791	8	23518.41	II	complex	407.65

TABLE 1—*Continued*

NO.	λI. A.	INT.	νVAC.	TEMP. CLASS.	ZEEMAN PATTERN	LINE STRUCTURE AND SEPARATIONS
18	4271.764	8r	23402.96	II	$\frac{(0)5}{4}$	
	4307.910	8r	23206.58	II	$\frac{(0)7}{6}$	388.37
	4325.770	9r	23110.76	II	$\frac{(0)7}{8}$	311.80
19	3969.263	7r	25186.48	II	complex	2+3+2
	4005.250	7b	24960.20	II	complex	
	4045.822	8R	24709.91	II	$\frac{(0)6}{5}$	584.70
	4063.604	8R	24601.78	II	$\frac{(0)12}{11}$	407.61
	4071.748	7r	24552.57	II	$\frac{(0)2}{3}$	476.57
	4132.064	7	24194.19	II	complex	358.40
	4143.874	7	24125.21	II	?	
20	4229.752	1	23635.39			
	4291.472	1	23295.48	IA		1+2+3+2
	4294.132	6	23281.05	IB	?	584.70
	4337.052	5	23050.64	IB	$\frac{(1)?}{2}$	407.62
	4367.910	1	22887.83	IA		474.87
	4383.548	10R	22806.18	II	$\frac{(0)8}{7}$	354.29
	4404.752	8r	22696.40	II	$\frac{(0)8}{7}$	244.80
	4415.127	8r	22643.06	II	?	

Structure of Multiplet 1

25900.00—240.19—26140.19
415.97 415.95
25484.03—240.21—25724.24—199.53—25923.77
288.10 288.10
25436.14—199.53—25635.67—139.68—25775.35
184.22 184.12
25451.45—139.78—25591.23—71.12—25662.35
89.92
25501.35

Structure of Multiplet 2

33905.93—411.20—33507.13
415.95 415.96
32679.98—411.19—33091.17—294.37—33385.54—145.44—33530.98
288.07 288.01 288.04
32803.10—294.43—33097.53—145.41—33242.94—70.14—33313.08
184.10 184.16 184.12
32913.43—145.35—33058.78—70.18—33128.96
89.95
33039.01

Structure of Multiplet 3

18776.96	—384.32—	19161.28						
240.18		240.16						
18536.78	—384.34—	18921.12	—272.53—	19193.65				
		199.55		199.50				
		18721.57	—272.58—	18994.15	—175.26—	19169.41		
				139.70		139.70		
				18854.45	—175.26—	19029.71	—86.01—	19115.72
						71.07		
						18958.64		

King[10] gives a table of twenty-one lines which appear in the furnace spectrum of iron at a temperature of 1400°C. Twelve of the stronger of these lines give multiplet No. 1.

Multiplet No. 2 is novel in that it has the same difference repeated three times in two instances. It will be noted that the lines involved are all reversed lines and of nearly the same temperature class. This anomaly occurs also in the multiplets given as Nos. 9 and 10.

Multiplet No. 3 is interesting in that the differences 240.17, 199.52, 139.70, and 71.07 are here related to the frequency so that in a given triplet, the larger difference occurs between the greater frequencies, while in multiplet No. 1, with the same differences, the greater difference occurs between the smaller frequencies involved in a given triplet.

The above-mentioned multiplets may be regarded as typical and the others are presented in Table 1 without individual comment at this time. It will be noted that there are altogether thirteen sets of separations involved in the twenty multiplets, one set recurring in nine multiplets. The total number of lines in Table 1 is 212. These include 102 of the 134 lines described by Burns as reversed in the arc and most of the lines of temperature classes I and II in King's furnace spectra are here represented. The correlation of these multiplets with temperature classification is seen to be fairly satisfactory, but inspection of the Zeeman patterns show that these data are homogeneous for some groups and quite discordant for others.

Some interesting relations have been found to exist between the different multiplets but a discussion involving a physical interpretation of these regularities is deferred until the spectrum has been more fully analyzed. A systematic analysis of all the available data on both arc and spark spectra of iron is in progress and the complete results of this investigation will appear later as a scientific paper of the Bureau of Standards.

[10] Astrophysical Jour. 45: 370. 1922.

BOTANY.—*Note on* Schizocasia Regnieri. K. KRAUSE, Berlin-Dahlem. (Communicated by PAUL C. STANDLEY).[1]

Among the plants collected in the Republic of Salvador by Dr. Salvador Calderón I have found a cultivated aroid which is to be identified as *Schizocasia Regnieri* L. Linden et Rod. This species, which is said to be a native of Siam, is cultivated as an ornamental plant in the tropics and in several hothouses of European and North American botanic gardens, but, as in the case of some other much cultivated aroids, until the present time it has not been known in flower. Because the Salvadorean specimen was collected in flowering state, I can now give, in addition to my diagnosis in the *Pflanzenreich* and to the earlier descriptions in the *Illustration Horticole* and the *Gardeners' Chronicle*, the following description of the inflorescence.

SCHIZOCASIA REGNIERI L. Linden et Rod. in Illustr. Hortic. **17**: *pl. 2.* 1887; Gard. Chron. **2**: 328. 1888; Krause in Engl. Pflanzenreich IV. **23E**: 117. 1920.—Tota planta usque 2.5 m. alta. Pedunculus teres superne circ. 1 cm. crassus. Spathae tubus convolutus anguste ovoideus, 4 cm. longus, 2 cm. diametiens, lamina oblonga, apicem versus longe sensimque angustata, quam tubus 4–5-plo longior, expansa ad 5 cm. lata. Spadix in toto fere 2.5 dm. longus, in vivo ut videtur flavido-albus; inflorescentia feminea cylindrica 3 cm. longa, 1.6 cm. crassa, interstitium sterile valde constrictum, 1.5 cm. longum, 6–7 mm. crassum; inflorescentia mascula cylindroidea, 4–5 cm. longa, 1.5 cm. crassa; appendix sterilis anguste elongato-claviformis, apice acutata, leviter curvata, 1.5 dm. longa, medio 1–1.2 cm. crassa, sursum attenuata. Flores feminei 4-gyni, pistillis late ovoideis depressis, 1 mm. longis, stigmate subcapitato leviter 4-lobo coronatis; flores masculi steriles synandrodiis cylindricis depressis directione spadicis compressis atque elongatis; flores masculi fertiles synandriis cylindricis vertice truncatis medio leviter excavatis, fere 2 mm. longis, 1 mm. latis, thecis anguste oblongis fere totam longitudinem synandrii occupantibus.

San Salvador, cultivated (*S. Calderón* 599).

[1] A specimen of a plant of the family Araceae was forwarded recently by the U. S. National Museum to the Berlin Botanic Garden for identification by Dr. K. Krause, the foremost authority upon this extremely difficult group. The specimen was collected by Dr. Salvador Calderón, an enthusiastic student of the Central American flora, who has made an extensive and valuable collection of Salvadorean plants and to whom the writer is under deep obligations for many courtesies extended during a recent collecting expedition in Salvador. From this material Dr. Krause has prepared the accompanying account, which completes the description of a striking ornamental plant whose characters have been hitherto but imperfectly known.—P. C. S.

ZOOLOGY.—*Notes on* Paratylenchus, *a genus of nemas.* N. A. COBB. U. S. Department of Agriculture.

The following paragraphs contain new information with regard to the lip region, vestibule, spear guide, structure of the spear, median bulb, salivary glands, deirids (cervical papillae), renette, eggs and their deposition, and gonism of *Paratylenchus* Micoletzky 1922.

Paratylenchus nanus n. sp. $\frac{8.2}{3.7}\ \frac{18.}{4.3}\ \frac{24.}{4.5}\ \frac{^{55}82.}{4.2}\ \frac{95.8}{2.}$ 0.41 mm The transparent, colorless, naked cuticle, about 1.5 microns thick, is traversed by plain, transverse striae, 2.0 microns apart except near the extremities, all alike and fairly easy of resolution, which are materially altered on the lateral fields by the presence of wing regions, about one-seventh as wide as the body, beginning on the neck and ending on the tail. The optical expression of the wings on living specimens usually consists in four parallel longitudinal lines on each lateral field, the two outer of which are fainter than the two inner. Very slightly oblique longitudinal striae of the subcuticle, all alike, due to the attachment of the musculature, are rather easily to be seen in nearly all regions of the body. The contour of the body is crenate or very faintly serrate-crenate. There are no dermal appendages and there are no series of pores to be seen in the cuticle. On the neck opposite the excretory pore, lat. 22.2,* *there is a papilla on each lateral line*, and, leading inward, ventrad and slightly backward from the middle of each papilla is an obscurely sinuous element connecting with the nervous system. These two organs are therefore *believed to be deirids* ("cervical papillae").

The neck, which is cylindroid posteriorly, and to a considerable extent also anteriorly, becomes decidedly convex-conoid farther forward, and ends in a rounded or subtruncate, continuous head compassing about thirty annules of the cuticle, which presents a somewhat depressed, very minute, central mouth opening, closely surrounded by *six equal, exceedingly minute lips*. The truncation of the head occurs at the lip region, which has at this point, that is at the anterior extremity of the nema, a width of about two microns. The lip region is supported by a faintly visible six-ribbed, refractive, somewhat dome-shaped, cuticular framework, six to seven microns across at the base, and about two-thirds as "high" as it is wide. The more or less immobile lips are usually closed.

* *The Word "Latitude" in Descriptive Nematology.* I have lately come to use the word "latitude" in a conventional sense in dealing with nema anatomy, and find it so useful as to lead to this attempt more accurately to define the word as thus used.

The meaning of latitude in this connection arises from geographical usage, but in nematology the term applies to a transverse plane or section of the organism, and not to a circle on the surface only, as in geography, and it has not seemed desirable to have two sorts of latitude, such as north and south.

One hundred degrees of latitude is assumed, with zero at the anterior extremity of the organism. Thus an element of the organism in latitude 50 would be at the middle; and in latitude 100 at the end of the tail. The terms can be abbreviated as in geography so as to be short and specific. Thus: *lat. 60.*

In the case of nemas, which are so nearly round in cross section, a similar use of the word "longitude" sometimes becomes useful, the ventral line being taken as the zero line, the dorsal line thus becoming 180.

The conventional use of the words latitude and longitude in this way is more or less "logical", and very easily acquired, and, according to my experience, is a decided saving in time and space, and has the merit of definiteness, as well as brevity.

There is a small *combined vestibule and spear guide*, about as wide as the lip region and some ten microns long, more or less visible on account of the refractive nature of its elements. This portion of the labial structure has for one of its main functions the guidance of the spear when in action. The vestibular part is about four microns deep and varies somewhat in diameter according to the attitude of the lips and spear. Leading backward from the base of the vestibule there is a symmetrical set of outwardly bowed, somewhat flexible, rather slender, longitudinal elements constituting the main portion of the spear guide. The relatively very robust spear is about twice as long as the base of the head is wide. It ends posteriorly in a distinctly three-lobed expansion toward one-third as wide as the base of the head, the dorsal lobe being slightly farthest back, and sometimes at least presenting a dorso-posterior condyle. It is somewhat behind, and in a line with, the axil of the dorsal lobe that the *dorsal salivary gland empties into the oesophageal lumen.* The spear often tapers more or less regularly throughout its length; nevertheless there is a distinct basal part, comprising about two-fifths of the whole, set off by a minute but distinct junction mark, and averaging about one-sixth as wide as the corresponding portion of the head. At its distal end the spear is exceedingly finely pointed. Well developed muscles for the protrusion of the spear are readily seen and often lie rather close to the spear,—not forming any very marked swelling when at rest. Anteriorly there are *six of these muscles,*—one passing to each sector of the labial framework.

No amphids have been seen. There are no eyespots.

The oesophagus is tylenchoid and presents a very definite, somewhat *pineapple-shaped, non-muscular valveless cardiac swelling,* half as wide as the base of the neck. The very long, large, rather ob-clavate, median swelling, which is two-thirds as wide as the middle of the neck, is set off abruptly behind, but is decurrent in front and reaches to, and somewhat includes, the base of the onchium; in its posterior part it presents a *well-developed, elongated-fusiform, triplex valve,* occupying one-third of the diameter, to which are attached the usual radial muscles for the opening of the valve in the act of swallowing. An interesting peculiarity of the median swelling is that the contained robust tubular oesophageal lining, which is *disposed in a single loop or coil when at rest, takes on this attitude without much disturbance to the evenness of the contour of the swelling* itself, thus showing the "clavate swelling" to be a distinctly two-fold affair,—partly (posteriorly) muscular, and partly (dorsally throughout) glandular, and with the two tissues so little connected that the glandular part is comparatively separate and responds but little to the movements of the tubular lining. Ordinarily one would expect the anterior narrower part of such a long median swelling to curve or coil along with the lining. Though the limits of the true median bulb (not the clavate swelling but the included median bulb more properly speaking), are often somewhat indefinite anteriorly, it may properly be described as ellipsoidal, two-thirds as wide as the neck and two and one-half times as long as wide; in other words the *entity of the median muscular bulb is not entirely lost.* Behind the pharynx the oesophagus is one-sixth, at the nerve ring only about one-tenth, in front of the cardiac swelling about one-eighth, and finally one-half, as wide as the corresponding portion of the neck. The lining of the oesophagus is tubular and narrow, and distinct except in the posterior glandular bulb,—most distinct in the clavate swelling.

There are *well developed salivary glands.* The nucleus of one of these organs may be seen in the dorsal sector of the cardiac swelling, as already described,—dorsad and occupying the major part of it,—and emptying into the oesophageal lumen near the onchium. It is doubtful if salivary secretion passes also into the base of the fusiform median valve, though there seem to be two subordinate nuclei in the cardiac swelling.

There are two or three somewhat ellipsoidal organs, half as wide as the body, about two-thirds as wide as long, located just behind the base of the neck, and closely associated with the beginning of the intestine. These regularly darken in Flemming's solution and are as yet of unknown significance. There is no cardia. The thick walled intestine, which is set off from the oesophagus by a rather faint cardiac collum one-half as wide as the base of the neck, presents a faint, though fairly capacious lumen. It is composed of cells of such a size that probably only about two are presented in each cross section. It becomes at once two-thirds as wide as the body. From the very inconspicuous, continuous anus, the rectum, which is also very inconspicuous, extends inward and forward. There is no distinct pre-rectum. The numerous, colorless granules found in the cells of the intestine, the largest of which are about one-tenth as wide as the body, namely about two microns in diameter, are not so arranged as to give rise to a tessellated effect. Sometimes the cells throughout the intestine are uniformly filled with granules; more often the granules are absent here and there, so as to create a "segmented" effect.

The tail, which compasses about twenty annules of the cuticle, is conoid, subarcuate, and tapers from in front of the anus to the rather blunt, or sometimes subacute, unarmed, symmetrical terminus. There is no spinneret. There are no caudal glands and there are no caudal setae.

Apparently the lateral chords are about one-third as wide as the body. The rather prominent excretory pore is located just behind the nerve ring and the excretory duct can be followed *inward and backward along the right lateral chord* at least as far as the middle of the body.

The nerve ring is oblique, of medium size and accompanied, fore and aft, by numerous nerve cells, some of which lie as far forward as opposite the middle of the median oesophageal swelling.

The single female sexual organ is outstretched forward. From the unusually large, depressed and very conspicuous vulva, the vagina, which is large, extends inward obliquely forward, three-fourths the distance across the body. Its walls are rather strongly cutinized. The larger anterior lip of the vulva may be slightly elevated. The body of the nema decreases a little in diameter rather suddenly at the vulva and tapers more rapidly thence backward. The thin-shelled, smooth, elongated egg is nearly thrice as long as the body is wide and measures about 60 x 20 microns. Only one egg occurs in the uterus at a time. A prolate *compact mass of sperm cells*, often comprising some two to five hundred minute, spherical, refractive elements, *occurs regularly in the uterus* of newly adult females; this sperm mass is often two-thirds to three-fourths as wide as the body. From the formation and size of the sperm cells it is concluded that the *species is syngonic*. No males have been seen among about fifty females, many gravid, from two North American regions. The medium sized ovary is usually cylindroid posteriorly, and tapers anteriorly; it averages to be about one-third as wide as the body. Toward fifty ova, arranged for the most part single file, are to be seen in the ovary. There is prac-

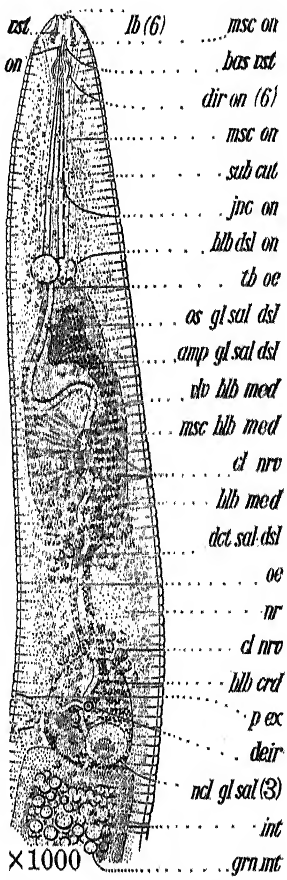

Fig. 1. Anterior part of a female *Paratylenchus nanus*.

Habitat: Found in soil about the roots of grasses, Devil's Lake, North Dakota, April, 1915; and Four Mile Run, Falls Church, Va., August, 1922. Flemming's solution to glycerine jelly. In many respects this species closely resembles *Tylenchus macrophallus* de Man, but differs in the following particulars;—the spear is somewhat longer and possibly somewhat more robust; the striation is coarser; the body is wider; the tail of *nanus* compasses twenty annules while that of *macrophallus* appears to compass about fifty; opposite the spear in *nanus* there are about twenty-five to thirty annules, while in *macrophallus* there appear to be about forty. Should opportunity occur it would perhaps be advisable to re-examine the median oesophageal region of *macrophallus*. For the present at least it seems best, unless the undiscovered male of *nanus* should prove to be extraordinarily like the male of *macrophallus*, to regard the two species as distinct. *Paratylenchus* is related to the very well-defined genus *Iota*, a genus whose numerous representatives typically are minute, very short, very broad, coarsely annuled, rather inflexible nemas found in acid soils, and having the single outstretched female sexual organ emptying through a vulva located very close to the minute, inconspicuous anus and often possessing external coarse retrorse cuticular elements,—ridges, scales, spines, fringes, etc., according to the species. There is a number of as yet unpublished species of which it is not easy to make a satisfactory assignment as between *Iota* and *Paratylenchus*. The unknown males of *nanus*, if such exist, may be expected to throw more light on the generic relationships. *P. nanus* may be synonymous with *P. bukowinensis* Micoletzky, 1922.

$$\frac{10.}{4.8}\quad\frac{26.}{\underline{5.1}}\ \ \frac{31.}{/\,5.\underline{6}}\quad\frac{{}^{33}\!-83.}{5.1}\quad\frac{93.}{3.1}\quad 0.36\text{ mm}$$ are the measurements of a living specimen of *P. nanus* under slight pressure and therefore a little flattened, and furthermore showing a neck-length unaltered by fixation and preservation.

Paratylenchus anceps n. sp. $$\frac{24.}{5.3}\quad\frac{28.}{\underline{5.3}}\ \ \frac{34.}{/\,5.\underline{3}}\quad\frac{Y}{4.6}\quad\frac{92.6(?)}{3.6}\quad 0.28\text{ mm}$$ *P. anceps* so closely resembles *P. nanus* that only the differences need be here noted. The striae are one micron apart. The optical expression of the wings is a pair of refractive parallel lines whose distance apart is about equal to the width of two annules of the cuticle. The conoid neck becomes convex-conoid at the head, at the front of which the lip region is about four microns wide. The spear guide is six microns long, and the spear about half as long as the neck, the long slender anterior part comprising three-fourths or four-fifths of the whole. The three-lobed, flattish basal bulb of the spear is about one-fourth as wide as the corresponding portion of the neck, that is about four microns wide. The somewhat elongated-pyriform or pineapple-shaped posterior bulb is three-fifths as wide as the base of the neck. The deirids are near the base of the neck. The tail is slightly conoid to the broad, rounded terminus, which is half as wide as the base of the tail. The vulva was about to appear at the same relative position as in *P. nanus*. In all other respects almost precisely as in *P. nanus*.

Habitat: Roots of *Umbellularia californica*, Riverside, California, 1912.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY OF WASHINGTON

354TH MEETING

The 354th meeting was held January 4th, 1923, in Room 43 of the New National Museum, with Vice-President A. G. Böving in the chair and 36 persons present.

Mr. Rohwer gave a résumé of the last meeting of the Executive Committee, stating that the Committee had approved certain changes in editorial practices and that beginning with Vol. 25 the inside of the back cover would be used for editorials and the outside for current notes. It is the plan that while these editorials and notes will be of timely interest, they will not contain scientific information which needs to be preserved.

The report of the recording secretary, C. T. Greene, was read and accepted.

The report of the corresponding secretary-treasurer was read by Mr. S. A. Rohwer and accepted.

The auditing committee, Messrs. A. N. Caudell and A. G. Böving, examined the Treasurer's books and reported them correct.

Dr. E. F. Phillips, of the Bee Culture Laboratory, extended an invitation to the Society to visit the laboratory at Somerset in the near future.

Program:

Presidential Address by the retiring president, A. B. Gahan on *The rôle of the taxonomist in present day entomology.* Man's first interest in insects probably came about through their ravages upon his person rather than upon his food supplies. Briefly tracing the history of the science from its possible prehistoric beginning down through recorded history to the present time, he sought to show that the whole immense entomological structure of to-day is based upon the work of the taxonomist; that without the trained systematist to identify and describe the species of insects, the economic worker was largely helpless. The world-wide interest in economic entomology has resulted in creating a veritable army of economic workers, while the number of systematists are called upon to do the determinating work in a large group of insects for all of the economic workers of the world. As a consequence, the work of the economist often times suffers exasperating delay because he can not get proper identifications promptly, and at the same time the taxonomist is discouraged because he sees himself hopelessly swamped with routine determination work and cut off from doing any of the constructive classification work which he had planned.

The remedy would seem to be in an immediate increase of the number of working systematists, but unfortunately this remedy cannot be applied, because trained systematists are not available, and if they were available it is very doubtful whether funds would be forthcoming from federal, state, or private institutions for their employment. The work of the taxonomist, even though it is the foundation of all entomological investigation, does not have the popular appeal which the economic phase of the work does and hence lacks the popular appreciation and support which it deserves.

In discussing the address Dr. Baker expressed the regret that so few people really made use of revisionary papers after they were published, and stated that while it seemed that such papers should relieve the taxonomist from considerable work of identification actually they did not, and that such revisions apparently failed to accomplish one of the purposes for which they were written.

Dr. ALDRICH stated that entomological courses in the larger universities had been changed considerably of late, and that only comparatively recently had any institution offered a course in taxonomy. This change in the curriculum of the larger universities should in time produce more taxonomists.

The paper was also discussed by Messrs. HYSLOP, BRIDWELL, SNODGRASS, HEINRICH, and SASSCER.

Second paper: Dr. J. M. ALDRICH. *A manuscript autobiography of S. W. Williston.* Dr. ALDRICH read the greater part of this manuscript which Dr. Williston wrote in 1916, about two years before his death. This dealt with the period of his childhood and early manhood and continued through a period of about eighteen years after graduating from college, during which he had a continuous struggle to obtain a foothold in science.

355TH MEETING

The 355th meeting was held February 1, 1923, in Room 43 of the New National Museum, with President Dr. L. O. HOWARD, in the chair and 30 persons present.

Program:

E. GRAYWOOD SMYTH: *A trip to Mexico for parasites of the Mexican Bean Beetle.* The speaker arrived in Mexico City on May 14th, 1922, and left there for the return trip on November 14th. Practically all studies and collecting were performed in the states of Morelos, Puebla and Vera Cruz, and the Federal District. In the lower altitudes, the beetle was not found in injurious numbers at the towns visited except at Cuernavaca. In the Federal District, on the high central plateau, there seems to be but one, and rarely two, generations of the beetle in a year, as in New Mexico, the first appearance of the adults being governed by the rainy season. Adults first appeared in early June, the first eggs during latter June, and the first larvae during the first week of July. Larvae were not large enough nor abundant enough to be injurious until the latter part of July. From that date on they thrived in abundance until October 9th, when a heavy frost killed all the bean plants in the Federal District.

No parasite was found of either the egg or adult of *Epilachna*. The only parasite encountered was a Tachinid fly, of about the size of the house fly, which attacks the larvae. It is apparently of a new genus and new species, and is being named by Dr. Aldrich. What was apparently this same fly was found attacking a related beetle, *Epilachna mexicana*, that feeds on a wild plant of no economic importance. This Tachinid was found only at or near Mexico City and at Cuernavaca. The first puparium was reared from an *Epilachna* larva on August 31st, and from that date the flies increased in numbers until early October, by which time they were parasitizing from 30 to 50 per cent of *Epilachna corrupta* larvae. It was not known why the flies were so late in making their appearance.

A total of 1866 living puparia of this fly, or *Epilachna* larvae parastized by the fly, were shipped and brought to the States, and approximately 50 per cent of these are now being held in hibernation at the Birmingham Laboratory for the coming spring. About 90 per cent of these came from the Federal District, from a town called Coapa. The author believes that this fly, if successfully colonized at Birmingham, would spread rapidly and do much toward control of the bean beetle.

Few predacious enemies were found, the only common one being a species of *Stiretrus* (Hemiptera, Pentatomidae), which was not sufficiently abundant to be of control value. A large number of egg masses of another predacious

bug, *Zelus* sp., collected on Agave plants near bean fields, were shipped to Birmingham, but the young nymphs, when reared at the latter place, refused to feed on *Epilachna* larvae.

As to wild food plants: the large numbers of leguminous plants and trees were examined for *Epilachna* in Mexico, only two were found to harbor the beetle. One is a wild climbing bean, *Phaseolus* sp., abundant along streams, the other a wild weed known as beggar-weed, or tick trefoil (*Meibomia* sp.) The latter harbored large numbers of bean beetles of all stages, and was believed to be the bettle's native wild food plant.

This paper was discussed by Messrs. ALDRICH, BRIDWELL, HOWARD and SCHWARZ.

Second paper: Dr. A. C. BAKER, *A history of the study of plant lice.*

Notes: J. C. BRIDWELL discussed the occurrence of the clover seed chalcid in the seeds of *Astragalus*.

Some months ago the speaker had reported the discovery of *Bruchophagus funebris* in pods of a species of *Oxytropis* (*O. lamberti*), a genus closely related to *Astragalus*. It is now possible to record an additional instance of attack upon an *Astragalus* by a *Bruchophagus*. This was discovered in a specimen of *Astragalus douglasii* in the National Herbarium collected on June 25, 1891 by Coville and Funston near Tehachipi, Kern County, California, at an elevation of 1000 metres. The *Bruchophagus* was accompanied in its attacks by *Acanthoscelides pullus* (Fall) and had at first been mistaken for a *Eurytoma* parasitic upon the Bruchid. The material from its age and its condition after having been extracted from the seed is not in the best of condition for determination and in it Mr. Gahan sees certain apparent differences of sculpture and color which do not permit him to positively determine it as *funebris* and suggest its belonging to another species, the question of its identity requiring biological evidence for its answer.

The finding of *Bruchophagus* in pods so different from the fruit of the previously known host plants in *Trifolium* and *Medicago* as the compact ovoid pods of *Oxytropis lamberti* and the large bladdery membranous pods of *A. douglasii* does not seem so strange when it is recalled that the oviposition is done early in the development of the young pod. How far the finding of additional host plants of *Bruchophagus* will effect practical control remains for investigation.

356TH MEETING

The 356th meeting was held March 1, 1923, in Room 43 of the New National Museum, with Vice-President Dr. A. G. BÖVING in the chair and 38 persons present.

Mr. ROHWER, for the Executive Committee, stated that since the last meeting the Society had received a communication from the Secretary of the International Commission of Zoological Nomenclature requesting that a committee be appointed to prepare preliminary reports on questions of Entomological Nomenclature referred to the Commission. President Howard had appointed as the Society's Committee, Messrs. ROHWER, HEINRICH and BAKER; and since the announcement of the Committee the Commission had referred three distinct questions to its Chairman.

F. W. Poos was elected to membership in the Society.

Program:

R. E. SNODGRASS: *The anatomy and metamorphosis of the apple maggot* (Rhagoletis pomonella *Walsh*).

The following generalizations probably apply to most of the *Cyclorrhapha:*

1. The true larval head has been invaginated to form a prepharyngeal part of the larval alimentary canal. The functional part of the larval head is a mere remnant of the original head.

2. The buds of the imaginal head are carried into the thoracic cavity by the involution of the larval head.

3. The cephalopharyngeal skeleton of the larva is a chitinization in the true larval pharynx, in the walls of the invaginated head, and in the pouches of the latter.

4. The mouth hooks of the larva are located in a part of the invaginated larval head which was either the back part of the original head, or the neck. They appear to be special cuticular larval organs moved by special muscles. No evidence of their mandibular nature has yet been produced.

5. The dorsal spiracles of the larva and pupa are special breathing organs secondarily developed in connection with the dorsal longitudinal trunks of the tracheal system. The spiracles of the adult first appear on the puparium, and are developed in connection with the lower tracheal trunks. The two sets of spiracles are entirely independent of each other.

The larva molts inside the puparium, casting a fourth skin which remains as an envelope about the pupa, unbroken until the fly emerges. The fly leaves both the pupal skin and the prepupal or fourth larval skin inside the puparium.

7. The pupa obtains air through the larval tracheal trunks attached to the anterior larval spiracles of the puparium, these trunks being ruptured inside the fourth larval skin a short distance back of the spiracles.

8. The imaginal buds of appendages belong in all cases to the pupal stage. They may secondarily begin their development in early larval stages or in the embryo, but only in cases where the external larval appendage is entirely gone.

Second paper: Carl Heinrich, *A revision of the North American moths of the subfamily Eucosminae of the family Olethreutidae.* Pierce's paper opens a new system of classification. In this genitalia take the place of the old wing venation type of classification. In time all species will be described from the male genitalia.

Notes: A. N. Caudell spoke of the collection of *Grylloblatta campodeiformis* Walker in California by H. S. Barber.

Dr. Schwarz exhibited two specimens of *Mylabris cichorii* L. and said this is a beneficial species, being used for medicinal purposes. This species is often eaten when the Chinese want to commit suicide.

Dr. Aldrich exhibited a photograph of a group of Dipterists taken in Boston at the recent meeting in December 1922.

J. C. Bridwell presented the following three notes:

1. *The habits of* Bruchus bixae.

In 1820 Drapiez described a species of *Bruchus* from Brazil which he believed bred in the seeds of annatto and called it *Bruchus bixae* from the generic name of the host plant, *Bixa orellana.* Since many old specific names of Brucidae based on plant names were in error and this record of a *Bruchus* in this plant so far removed from the legumes in its natural relationships and in the nature of the seeds and pods has never been confirmed, it has been a matter of interest to find what seems to be this species bred from this host plant collected by Dr. Schwarz in Panama. In this material was a considerable lot of the capsules and seeds of Bixa infested by *Bruchus bixae.* The adult Bruchids slip in between the partly opened valves of the pod to oviposit upon the seeds in a sheltered position much as its allies *B. pruininus* and

. *limbatus* oviposit in the partly opened pods of *Leucaena, Pithecollobium* ıd various species of *Acacia.* No eggs were seen deposited upon the pods.

The seeds are irregularly pyramidal broadest and flattened at the summit ɔout 4 mm. broad and 5 mm. long with a peculiar scar-like structure at the ımmit. The rest of the surface of the seed is covered with small masses of soft, reddish-orange waxy substance from which the annatto of commerce is erived, the source of most commercial cheese and buttercolor and of some ıferior varnish stains and dyes for silk. The eggs are deposited singly upon he seed and a single Bruchus is nourished by a seed. The cotyledons are road and foliaceous disposed between thick masses of soft brittle albumen hich is largely consumed by the larva during its development as in the case f the Bruchidae attacking the seeds of *Hibiscus, Ipomoea* and *Convolvulus.*

The eggs are nearly hemispherical, but little flattened by the copious cement ubstance and show but little reticulation on the surface. The larvae as ısual bore directly into the seed when emerging from the egg.

The present species may be expected to continue breeding indefinitely in he annatto seeds as long as they are kept at a temperature high enough, but ittle injury is done to the seeds so far as the coloring matter is concerned. Their presence, however, is undesirable and they would be likely to destroy eed designed for planting. The maceration of the seed in boiling water in xtracting the color would doubtless destroy the insects contained in the seed.

2. *Retarded development in* Eurytoma rhois.

What was believed to be this species was found very commonly by Miss Marion Van Horn in the seeds of *Rhus glabra* and *R. typhina* during the winter of 1921–22 in the vicinity of Washington. The material collected in January had the larvae full-fed and in a very thin membraneous coccoon lining the seed cavity. The material was brought into the laboratory of the Division of Stored Product Insects and held for breeding out. Few adults emerged, but on the examination of the seeds in February 1923 a considerable part of them had transformed and died without emerging probably owing to the excessive heat and dryness of the laboratory. There were also in the seeds a considerable number of living full-fed larvae. There is then in this species of phytophagous chalcid a phenomenon of retarded development such as has been recorded for the clover seed chalcid and some of the Opiine Braconidae. It is likely that most of the seed chalcids will be found to have the same ability to remain dormant in the full-fed larva for extended periods under adverse conditions of drought or subnormal temperatures and this will need to be guarded against in the control and quarantine of such insects. This phenomenon is doubtless far more common than has been recorded for it is questionable if insects in regions with a variable winter climate or those arid regions where effective rainfall may be absent for a year or more could survive if compelled to depend upon steady straightforward development in conformity with the calendar.

The seeds of *Ceanothus americanus* are infested in this vicinity by a seed chalcid not yet bred. As in other cases the seeds often show no external sign of infestation. The larva completely destroys the seed leaving only the coverings.

3. *Pupae of the walnut hull maggot living two years* (Rhagoletis suavis Loew).

During the fall of 1920 the writer secured many walnut hull maggots in and near Glen Echo, Maryland. The puparia from these were brought into the laboratory of the Division of Stored Product Insect investigations. Emergence of 23 adults was noted on March 8, 1921. From that time until June 21 scattering emergence continued, usually not more than one

each day. The material, having become badly infested by mites, was then fumigated. Another small lot was overlooked and remained uncared for until the latter part of the winter 1921–22 when several puparia were found to contain pupae in a living condition. An effort was made to secure emergence from this lot by keeping them moist but without success. Several pupae remained alive until the latter part of the summer of 1922 but all were dead by the middle of November 1922, thus remaining alive as pupae for nearly two years. This material had been left in glass without soil. No inhabited room would seem to be much more unfavorable for dipterous pupae than this laboratory since in the winter it is overheated and the air is exceedingly dry, the temperature reaching 80° to 85°F. daily. Under certain conditions, then, walnut maggots may not complete their transformations in a single year but can remain in the puparium for two years if not more. While this observation was fragmentary, undoubtedly this is normal to the insect's life history, since a species dependent on an uncertain crop such as the nuts of the walnut and butternut could hardly survive if a single year's failure of its food would starve it out. This result would be avoided if some pupae held over to another summer or longer.

F. P. KEENE of the Pacific Coast Station of the Division of Forest Insects made a few remarks on the control of the pine bark beetles in Southern Oregon. During the past year the insect damage dropped 72%. Mr. Keene exhibited a chart showing the damage to the trees in Southern Oregon and Northern California caused by insects and fire.

CHAS. T. GREENE, *Recording Secretary.*

AN APPEAL FOR AID TO AUSTRIAN SCIENTISTS

There has recently been referred to the WASHINGTON ACADEMY OF SCIENCES a report on the condition of Intellectual Life in Austria, from the committee on Intellectual Cooperation of the League of Nations. This was referred by the Board of Managers to a committee consisting of A. S. HITCHCOCK, VERNON KELLOGG, and H. L. SHANTZ, who have been authorized by the Board to issue the following statement.

The report on intellectual life in Austria outlines the deplorable conditions at the universities, the very meager salaries (in depreciated crowns) received by the professors, and the high cost of living. Attention is called to the work of the Academy of Sciences at Vienna, which institution has been obliged to discontinue subscriptions to publications and to cease printing reports of its proceedings.

Relief along certain lines is now being afforded. The American Relief Administration is still continuing a so-called "professors' mess" which is providing a daily meal of excellent quality to more than three hundred professors and instructors at a merely nominal price. Although the American Relief Administration has given up all of its other work (such as child feeding) in Austria it still carries on this special relief for intellectuals in Vienna, Graz, and Innsbruck, that is, in each university city. The Rockefeller Foundation is just making arrangements to set up a considerable number of "fellowships" to assist the younger men of the Austrian university faculties. In addition, the Foundation is making some financial provision for the purchase of laboratory equipment and supplies in the laboratories of medical schools. It has also been arranged to pay subscriptions to American medical journals for these medical schools.

It is evident that there is a very real need for necessities other than food. The table of salaries given in the report shows that an ordinary professor in the University receives per month the equivalent of about 150 Swiss francs ($30.00). The cost of living is very high when compared with the salary received but is low when compared with prices in this country. It is clear that 10 dollars contributed for relief becomes greatly magnified when translated into crowns (exchange being now about 14 dollars per million crowns). In this connection may be quoted from Dr. Kellogg's report in Science (April 6, 1923) concerning contributions to Russian Exiled Intellectuals in Berlin when $1200 were collected and distributed, 10 or 12 dollars to each person, "I hope that each donor will realize how much his money is doing. Ten dollars make the difference between suicide and keeping alive some of these people." Intellectual workers as a class are worse off than most other classes since the adjustment of their salaries to cost of living takes place much more slowly. So large a proportion of a professor's salary must go for food that little is left for clothing and other necessities. Owing to the present boundaries of Austria many necessities must be imported at prices far beyond the reach of a scientist's salary. How to get a pair of spectacles or a pair of shoes is a harassing problem that a few American dollars can solve. Since coal also must be imported the buildings are not heated. The vast herbarium of the Naturhistorisches Museum has not been heated since 1914. Working under such circumstances warm clothing is sorely needed but, except for those with friends in America, the people are still wearing the threadbare garments of several years ago. Nothing is left of a professor's salary for the needs of the intellectual life. Concerning the last the report says, "Owing to the rate of exchange, a barrier, which is becoming more difficult to surmount, has been set up between Austria and the rest of the world, and this prevents all intellectual intercourse, all contact between Austrian science and the science of other countries. In short intellectual life is threatened with extinction through being abandoned, isolated, and starved."

It is suggested that the most effective method by which Washington scientists can aid the intellectual workers of Austria is by direct contributions from individual members of the Academy to individual scientists in that country with whom they have established contact personally or by correspondence.

There are probably many, however, who do not have personal friends in Austria but who wish to contribute for the sake of preventing the collapse of scientific investigation in that country.

Contributions may be sent to Mrs. Agnes Chase, Smithsonian Institution, who will represent the Chairman of the committee during his absence in South America. The Committee hope there may be a wide response to this appeal as there is a very pressing need.

It is suggested that donors indicate whether the gift should be sent (a) to an individual, or (b) to a class of scientists, or (c) to the Vienna Academy of Sciences or other institution, or (d) unrestricted, and (e) whether for a particular purpose.

It should be impressed upon donors that a gift of five or ten dollars will be a very real benefit and will be greatly appreciated, and that aid from members of the Academy will demonstrate the solidarity of international science.

There will be no overhead expenses in connection with transmitting gifts. Mrs. Chase will pay postage and fee for registering.

SCIENTIFIC NOTES AND NEWS

At the Bureau of Standards Physics Club, Monday, May 14, Dr. L. B. TUCKERMAN made an informal report on the lectures delivered at the Franklin Institute by Sir J. J. THOMSON on *The electron in chemistry*.

Dr. PAUL BARTSCH, U. S. National Museum, left April 29 for Porto Rico on a collecting trip.

Dr. C. N. FENNER of the Geophysical Laboratory, Carnegie Institution of Washington, left on May 14 to spend the summer in the Katmai region, Alaska, to continue his studies of the phenomena of the 1912 eruption of Katmai Volcano.

Dr. A. S. HITCHCOCK, Smithsonian Institution, left in May for South America where he will make botanical collections. Three months will be spent in Ecuador, the work being a continuation of the coöperation between the U. S. Department of Agriculture, the U.S. National Museum, the Gray Herbarium, and the New York Botanical Garden in studying the botany of northern South America. About three months will be spent in Peru and Bolivia studying grasses for the Department of Agriculture.

Mr. NEIL M. JUDD, curator of American Archeology, U. S. National Museum, left Washington on May 4 to resume his explorations at Pueblo Bonito, New Mexico.

Mr. ELLIOT WOODS, architect of the Capitol, died at Spring Lake, New Jersey, on May 22, 1923 in his sixtieth year. He was born near Manchester, England, February 2, 1864, of American parents. Mr. Woods had been employed in the office of architecture in Washington since 1884. He was largely responsible for the plans of many public buildings, including the Senate and House office buildings and the Arlington amphitheater. His interest in science was mainly in astronomy and electricity. He was a member of the Washington Society of Engineers and of the Philosophical Society.

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GEOPHYSICS.—*Some recent progress in isostatic investigations.*[1] William Bowie, Chief, Division of Geodesy, U. S. Coast and Geodetic Survey.

The theory of isostasy seems to be gaining in favor with geophysicists and geologists. This is shown by the progress made during the past year or two.

The holding of a symposium on isostasy by the Geological Society at its annual meeting at Amherst, Massachusetts, in December, 1921, indicated the interest which geologists are taking in the subject.

At the symposium, the papers presented covered a wide field. Nearly all of them attempted to show some relation of isostasy to geological problems and phenomena. The papers appeared in the June, 1922, number of the Proceedings of the Geological Society of America.

At the meeting of the Society in December, 1922, held at Ann Arbor, Michigan, there were a number of papers in which isostasy was given some consideration.

One of the most valuable additions to isostatic literature is "The Strandflat and Isostasy," by Fridjhof Nansen, published in "I Kommission Hos Dybwad," in December, 1922. In this book of more than 300 pages, the author shows that the isostatic balance was maintained almost, if not perfectly, in Norway during the loading of the area by ice-caps and after their disappearances. He makes out a strong case for isostasy which should be considered by those studying the processes operating in the earth's crust.

In addition to the papers referred to above, several others have appeared in Italy and the United States.

At the meeting of the Section of Geodesy, of the International Geodetic and Geophysical Union, held at Rome, Italy, in May, 1922, isostasy was given some consideration. Efforts are now being made

[1] Presented at meeting of the Section of Geodesy of the American Geophysical Union, at Washington, D. C., April 19, 1923. Received June 8, 1923.

to bring the subject before the geodesists of the countries adhering to the Union with a view to having it considered in detail at the meeting of the Geodetic Section which will be held at Madrid, Spain, in 1924. At that meeting it is hoped some definite plan may be adopted for applying the theory of isostasy to the treatment of gravity and deflection of the vertical stations. It is very desirable that uniformity in the treatment be agreed to by the several countries.

The field work done in the United States by the Coast and Geodetic Survey during the year, which can be used in isostatic investigations, consists of astronomic observations for latitude, longitude, and azimuth at triangulation stations, and the establishment of gravity stations.

The locations of eighteen of the gravity stations were selected by Dr. David White of the U. S. Geological Survey with a view to testing the effect on the value of gravity of variations from normal density in the material near the stations. The computation and adjustment of the observations made have been completed, and the results furnished to Dr. White. He expects to make an analysis of the data in the immediate future.

There are a number of localities in the United States where there are gravity stations close together which show great differences in the anomalies in very short distances. In the vicinity of Puget Sound the gravity anomaly at the Seattle station is −0.093 dyne, while at a point 15 miles to the westward the anomaly is only −0.025 dyne, and at a distance of 20 miles to the northwest of Seattle the anomaly is +0.002 dyne. At Tacoma, 27 miles south of Seattle, the anomaly is −0.012 dyne, and at Olympia, 50 miles to the southwest, the anomaly is +0.033 dyne.

There is an anomaly of +0.059 dyne at Minneapolis, while at Baldwin about 40 miles east of that place the anomaly is −0.050 dyne. At Damon Mound, in Texas, the difference in anomaly at two stations only seven miles apart, is 0.035 dyne. At Compton, California, the anomaly is −0.050 dyne while at two stations within 11 miles of Compton the anomalies are much less.

When it is considered that an anomaly of 0.001 dyne will be caused by the attraction of a disc of material of indefinite horizontal extent and 30 feet in thickness, we can realize that the differences in anomalies at some of the groups of stations in the United States represent the positive or negative attraction of large masses of material. It is certain that the cause of these differences in the anomalies must be in the upper part of the crust very close to the stations. If the causes

were deep-seated or were the lack of isostatic balance of the earth's crust near the groups of stations, there would not be such decided differences in the anomalies.

The accumulated geodetic data seem to indicate very clearly that the causes of large gravity anomalies are very local and probably are masses of extra light or extra heavy material close to the gravity stations. This being the case, we must conclude that the earth's crust is in a more nearly perfect state of equilibrium than has previously been supposed.

Late in 1921, eight gravity stations were established on or near the Mississippi River Delta in order to test the isostatic equilibrium of the earth's crust under the delta. A station already existed at New Orleans.

The average anomaly with regard to sign at eight stations on the delta is -0.007 dyne. Four of the anomalies are negative and four positive. The results seem to indicate already that the crust under the delta is in isostatic equilibrium and that the delta material is not an extra load on the crust. The average negative anomaly is due to the presence of abnormally light materials near the gravity stations. This conclusion is opposed to that of Barrell. He believed a study of the deltas of the rivers Niger and Nile showed them to be extra loads.[2]

It is hoped that gravity stations may be established on other well defined deltas for there is no better geological formation on which to test the theory of isostasy.

The really important problem in isostasy today is the use of the theory in geological research. The theory is widely accepted, but there still remains much confusion even in the minds of many of its advocates. Some claim too much for it while others do not give it sufficient credit.

The geodetic data in the form of values of gravity and the deflections of the vertical are facts. So also are the computed effects of topography. From these data we arrive at conclusions as to the isostatic condition of the earth's crust. These conclusions cannot be classed as mere speculations for they are based on logical processes of reasoning. Of course, assumption must be made as to the distribution of the isostatic compensation horizontally and vertically from topographic features. But even here there is evidence that the distribution probably takes place within certain limiting distances. One of the results of the acceptance of the theory of isostasy will be the

[2] *The strength of the earth's crust*, by Joseph Barrell, Journal of Geology, January–February, 1914.

modification of certain theories relating to crustal movements which were advanced before the theory of isostasy had been quantitatively studied.

SPECTROSCOPY.—*Regularities in the arc spectrum of titanium.*[1] C. C. KIESS and HARRIET K. KIESS, Bureau of Standards. (Communicated by Dr. W. F. MEGGERS.)

Until recently our knowledge of the series regularities occurring in spectra extended only to the elements hydrogen and helium, those of the first three columns of the periodic classification, and also the elements oxygen, sulphur and selenium of the sixth column. The more complex spectra of the elements occupying columns IV to VIII have for the most part remained unresolved. The extension of our knowledge of spectra into hitherto unexplored regions, the successful explanation of known spectrum regularities on the basis of modern atomic theories, and the recent discovery of new types of regularities in complex spectra have all inspired new attacks on the more complex spectra with successful results for chromium[2] and molybdenum[3] of column VI, for manganese[4], of column VII, and for iron[5] of column VIII.

The element titanium, of atomic number 22, is a member of column IV of the periodic classification. Its arc spectrum is of importance in astrophysics, the titanium lines occurring in all classes of stellar spectra from Type A to Type M of the Harvard Classification. In the spectrum of the sun practically all the more intense arc lines of titanium were identified by Rowland[6] from wave length 3000 A up to approximately 6900 A, and by Meggers[7] from wave length 6900 A to 9000 A. According to Adams[8], 91 per cent of all the titanium lines lying between 4000 A and 7000 A are strengthened in sun-spot spectra.

The arc spectrum of titanium has been measured from wave-length 2400 A in the ultra-violet to 9700 A in the infra-red. In Kayser's *Handbuch*, vol. 6, is given a summary of all the wave-length data pub-

[1] Published by permission of the Director, Bureau of Standards. Received June 17, 1923.

[2] Ann. der Physik, IV, **69**: 147. 1922; Science, **56**: 666. 1922; Anales Españ. de Fis. y. Quim., **21**: 84. 1923.

[3] B. S. Sci. Papers, In press.

[4] Proc. Roy. Soc. London A **223**: 146. 1922.

[5] Journ. Wash. Acad. Sci. **13**: 243. 1923.

[6] Prelim. Table Solar Spectrum, Chicago, 1896.

[7] Publ. Allegheny Observ., **6**: 13. 1919.

[8] Astroph. Journ. **30**: 86. 1909.

lished up to the year 1912. Since that time have appeared measurements by Kiess and Meggers[9] describing the spectrum from 5500 A to 9700 A in international units, and interferometer measurements by Brown[10] of 118 lines between the limits 4263 A and 6261 A. The character of the spectrum as a function of the temperature of the source has been studied by King[11] who has given the temperature classification of all the arc lines from 3888 A to 7364 A. King[12] also studied the Zeeman effect for the titanium spark in approximately the same spectral regions.

It is the purpose of this note to describe regularities of complex type that have been found to occur among the arc lines of titanium. In describing similar complex groups which he found in the spectrum of manganese, Catalán[13] coined the name multiplet for them. The multiplets of titanium are characterized by two different sets of recurring constant frequency differences. The differences 170.1 and 216.7 link together groups of six and seven lines similar to those found by Popow, Götze, Lorenser and others[14] in the spectra of the alkaline earths and of some of the elements of column III. The differences 42.0, 62.3, 81.7 and 100.2 occur in more complex groups of 11 and of 13 lines similar to the multiplets of manganese,[15] or those of chromium[16] and molybdenum.[17]

The majority of the lines so far classified belong to King's temperature classes I and II, although some of classes III and IV have been assigned to multiplets. It is worth while to remark here that the temperature classification of spectrum lines is an invaluable aid in unravelling complex spectra, furnishing clues which lead readily to the sought-for regularities. In each of the following groups the wave-lengths of the lines are followed by parentheses in which the arabic numeral gives the arc intensity of the line as taken from published data, and the Roman numeral gives the temperature class of the line. Beneath the wave-length is printed the wave-number of the line corrected to vacuum. The italicized numbers give the frequency differ ences occurring between the connected pairs of lines.

[9] B.S. Sci. Papers, **16:** 51. 1920.
[10] Astroph. Journ. **56:** 53. 1922.
[11] Astroph. Journ. **39:** 139. 1914.
[12] Astroph. Journ. **29:** 76. 1909; also **30:** 1. 1909.
[13] Proc. Roy. Soc. London, *A* **223:** 146. 1922.
[14] Paschen-Götze, Seriengestze, Berlin, 1922.
[15] Loc. cit.
[16] Ann. der Physik, IV **69:** 147. 1922, Anales Españ. de Fis. y Quim. **21:** 84. 1923.
[17] B. S. Sci. Papers, In press.

Multiplets in the arc spectrum of titanium:

Group 1.

	5152.18 (4I)	5210.39 (6I)
	19403.87 *216.79*	19187.08
	152.41	*152.40*
5147.49 (4I)	5192.97 (6I)	5252.11 (2I)
19421.55 *170.09*	19251.46 *216.78*	19034.68
98.55	*98.66*	
5173.74 (6I)	5219.72 (2I)	
19323.00 *170.20*	19152.80	

Group 2.

	3964.27 (7II)	3998.64 (10II)
	25218.20 *216.76*	25001.44
	161.14	*161.04*
3962.86 (7II)	3989.77 (10II)	4024.57 (8II)
25227.17 *170.11*	25057.06 *216.66*	24840.40
124.63	*124.44*	
3982.54 (5II)	4009.68 (4II)	
25102.54 *169.92*	24932.62	

Group 3.

	3914.33 (7II)	
	25539.98	
	216.21	
3921.42 (5II)	3947.75 (8II)	3981.77 (8II)
25493.76 *169.99*	25323.77 *216.38*	25107.39
54.74	*54.65*	
3929.86 (6II)	3956.28 (10II)	
25439.02 *169.90*	25269.12	

Group 4.

3717.39 (5)	3741.06 (6)	3771.04 (4)
26893.00 *170.18*	26722.82 *216.67*	26506.15
118.09	*118.16*	
3733.78 (2)	3757.68 (3)	
26774.91 *170.25*	26604.66	
52.66		
3741.14 (5)		
26722.25		

Group 5.

		3642.68 (10)		3671.66 (5)
		27444.56	*216.64*	27227.92
		134.54		*134.55*
3637.96 (3)		3660.62 (5)		3689.89 (5)
27480.16	*170.14*	27310.02	*216.65*	27093.37
62.10		*61.99*		
3646.19 (3)		3668.95 (5)		
27418.06	*170.03*	27248.03		

Group 6.

		2937.30 (8)		2956.13 (8)
		34034.90	*216.73*	33818.17
		126.36		*12.635*
2933.53 (8)		2948.25 (8)		2967.22 (10)
34078.64	*170.10*	33908.54	*216.72*	33691.82
97.98		*98.02*		
2941.99 (10)		2956.80 (10)		
33980.66	*170.14*	33810.52		

Group 7.

								*4981.73 (10II)
								20067.75
								137.71
						*4991.07 (9II)		5016.16 (4II)
						20030.21	*100.17*	19930.04
						115.53		*115.62*
				*4999.50 (9II)		5020.02 (5II)		5045.43 (2IIIA)
				19996.44	*81.76*	19914.68	*100.26*	19814.42
				93.01		*93.03*		
		*5007.21 (8II)		5022.86 (4II)		5043.59 (2IIIA)		
		19965.66	*62.23*	19903.43	*81.78*	19821.65		
		70.03		*70.15*				
*5014.28 (8II)		5024.83 (4II)		5040.63 (2IIIA)				
19937.52	*41.89*	19895.63	*62.35*	19833.28				
		45.97						
		5036.47 (4II)						
		19849.66						

* *Raies ultimes.*

Group 8.

			8267.62 (1) 12092.06	
			139.60	
		8307.41 (1) 12034.14 *81.68*	8364.18 (2) 11952.46 *100.19*	8434.89 (4) 11852.27
		101.15	*101.25*	
	8334.42 (2) 11995.14 *62.15*	8377.83 (2) 11932.99 *81.78*	8435.64 (5) 11851.21	
	68.95	*68.86*		
8353.12 (2) 11968.30 *42.11*	8382.61 (3) 11926.19 *62.06*	8426.46 (4) 11864.13		
	42.15			
	8412.34 (3) 11884.04			

Group 9.

			4512.73 (8II) 22153.35 *100.30*	4533.25 (9II) 22053.05
			107.73	*107.63*
		4518.02 (8II) 22127.42 *81.80*	4534.78 (9II) 22045.62 *100.20*	4555.49 (7II) 21945.42
		85.70	*85.56*	
	4522.80 (8II) 22104.04 *62.32*	4535.58 (4II) 22041.72 *81.66*	4552.45 (8II) 21960.06	
	63.97	*63.89*		
4527.31 (6II) 22081.98 *41.91*	4535.92 (6II) 22040.07 *62.24*	4548.77 (8II) 21977.83		
42.30	*42.52*			
4536.00 (5II) 22039.68 *42.13*	4544.69 (8II) 21997.55			

Group 10.

			4295.75 (5II) 23272.32 *100.30*	43.14.34 (3III) 23172.02
			23.31	*23.02*
		4284.99 (4III) 23330.74 *81.73*	4300.05 (4V) 23249.01 *100.01*	4318.63 (5III) 23149.00
		79.52	*79.46*	
	4288.18 (3III) 23313.39 *62.17*	4299.64 (5III) 23251.22 *81.67*	4314.80 (3II) 23169.55	

	251.03	*251.19*
4326.98 (2III)	4334.86 (3III)	4346.60 (3IV)
23104.34 *41.98*	23062.36 *62.33*	23000.03

405.49	*405.48*
4404.28 (5III)	4412.44 (2III)
22698.85 *41.97*	22656.88

The lines which have thus far been classified are about 100 in number, or very nearly 10 per cent of the total recorded for the arc spectrum. Work is still in progress and it is hoped to present more complete details of the investigation in the Scientific Papers of the Bureau of Standards. The element zirconium, of atomic number 40, follows titanium in column IV of the periodic classification. We have found in its spectrum multiplets similar to some of those recorded below. We expect also to present the details of this investigation in the near future.

CHEMISTRY.—*The oxides of iron.*[1]

JOHN B. FERGUSON, University of Toronto.

In spite of the large amount of work that has been done upon the problem of the oxides of iron, our knowledge of this subject is far from complete. In particular, diverse views are held as to the nature of the iron phase, the nature of the ferrous iron phase, and the proper values of the equilibrium constants in the system—(H_2,H_2O, Fe, FeO).[2] The present paper deals with these points.

I. THE IRON PHASE

Mixtures of hydrogen gas and water vapour at atmospheric pressure were passed over iron at high temperatures and the resultant degree of oxidation noted.

The charge was placed in a porcelain boat in an electrically heated tube furnace and the furnace swept out with oxygen-free nitrogen. The furnace was then brought up to temperature and the gas mixture admittted. At the end of the experiment, the gas mixture was swept out with the nitrogen and the charge allowed to cool. When it was cold it was removed and analyzed.

[1] Received May 23, 1923. The experimental work on which this paper is based was in part carried out by Messrs. Findlay, Robertson, Noble, Hoover and Mulligan. See *Transactions of the Royal Society of Canada,* **15**: 55. 1921; **16**: 273. 1922; and the volume for the current year.

[2] Fe and FeO are here used to designate the phases and are not meant to indicate the exact compositions of these phases.

Commerical hydrogen and nitrogen were used. Both were passed over hot copper to remove oxygen, and the nitrogen was in addition carefully dried. The purified hydrogen contained not over 0.2 per cent of nitrogen and allowance was made for this in the calculations.

The gas mixtures were prepared by passing the hydrogen through wash bottles, containing distilled water, immersed in an electrically controlled thermostat.

Electrically heated connecting tubes prevented the water from condensing out of the gas mixture prior to its reaching the hot zone of the furnace.

TABLE I.—Experiments on the Nature of the Iron Phase

Experiment number	Temperature deg. C.	Time, hours	Ratio H_2O/H_2	Iron content, per cent		Remarks
				Initial	Final	
1	750	6	0.476	100	99.98	Pure iron
2	750	6	0.540	100	99.90	Pure iron
3	750	6	0.33	99.78	99.67	Piano wire
4	980	6	0.44	100	99.86	Pure iron
5	960	6.5	0.44	100	100.1	Pure iron
6	960–80	6	0.44	98.88	99.84	Oxidized iron

A carefully calibrated thermoelement and a potentiometer served for the temperature measurements.

The initial and final products were analyzed for total iron. Both the usual permanganate method and the dichromate electrometric method were employed.[3]

The pure iron was an electrolytic product which had been reduced for many hours at 900°–1000°C. with dry hydrogen. Permanganate titrations indicated 99.90 and 100.0 per cent iron while dichromate gave 100.1 and 99.95 per cent. It contained no manganese and less than 0.05 per cent carbon.

The results of the best controlled experiments are given in table I.

The first five experiments do not indicate that pure iron will take up oxygen to form solid solutions. One might say, however, that such solutions are stable but that their rate of formation is such that they did not have time to form. This hypothesis seems improbable but was worth checking. Experiments at 750°C. afforded no information on this point. Even with dry hydrogen, a slightly oxidized iron sample

[3] Mr. Mulligan was unable to detect any difference between the oxidizing strengths of these solutions such as was recently reported to exist. *Journ. Am. Chem. Soc.* **44**: 2148. 1922.

could not be completely reduced though heated for many hours.[4] An experiment at a higher temperature was more successful. Experiment 6 shows that the hypothesis is untenable.

The results appear to be evidence in favour of the view[5] that in the (H_2H_2O, Fe, FeO) system, the iron phase contains no appreciable amount of oxygen but is practically pure iron.

II. THE FERROUS IRON PHASE

That ferrous oxide may take up ferro-ferric oxide in solution seems to be fairly well established.[6] The available equilibrium measurements[7] indicate that this ferrous oxide phase is unstable at low temperatures and Chaudron[8] has qualitatively checked this theoretical possibility. At 1100°C. Hilpert was able to prepare an iron-free ferrous oxide containing 1.5 per cent of ferric oxide but at 700°C. the ferrous oxide he obtained, free from metallic iron, contained some 15

TABLE II.—Analyses of Samples used

SAMPLE	FREE IRON	FERROUS IRON	FERRIC IRON	TOTAL IRON	METHOD OF PREPARATION
I	Trace	78.16	21.84	76.03	750°C. H_2,H_2O
II	0.72	87.48	11.80		800°C. H_2,H_2O
III	Trace	84.65	15.35		920°C. CO,CO_2

per cent of the higher oxide. The synthetic experiments of Hilpert furnish the only information we have upon the relative stability of the ferrous oxide solid solutions. This question of relative stability seemed to us to merit further investigation.

We have prepared from pure iron, using suitable gas mixtures of hydrogen and water vapour, many samples intermediate in composition between FeO and Fe_3O_4. Two such samples and a third sample, made with a gas mixture of carbon monoxide and carbon dioxide, were selected as materials suitable for a study of the invariant point, at which the ferrous oxide and iron phases are in equilibrium with the

[4] Similar results are reported by Richards and Baxter. *Z. anorg. allgem. Chem.* 23: 245. 1900.

[5] R. B. Sosman, This Journal 7: 56. 1917.

[6] Hilpert and Beyer, *Ber. deutsch. Chem. Ges.* **44**: 1908. 1911. Matsubara, *Trans. Am. Inst. Mining Met. Eng.*, reprint 1051, issued with Mining and Metallurgy, February, 1921.

[7] For a summary of these, see the paper by Eastman. *Journ. Am. Chem. Soc.* **44**: 975. 1922.

[8] Chaudron, *Annales de Chimie*, **16**: 221. 1921.

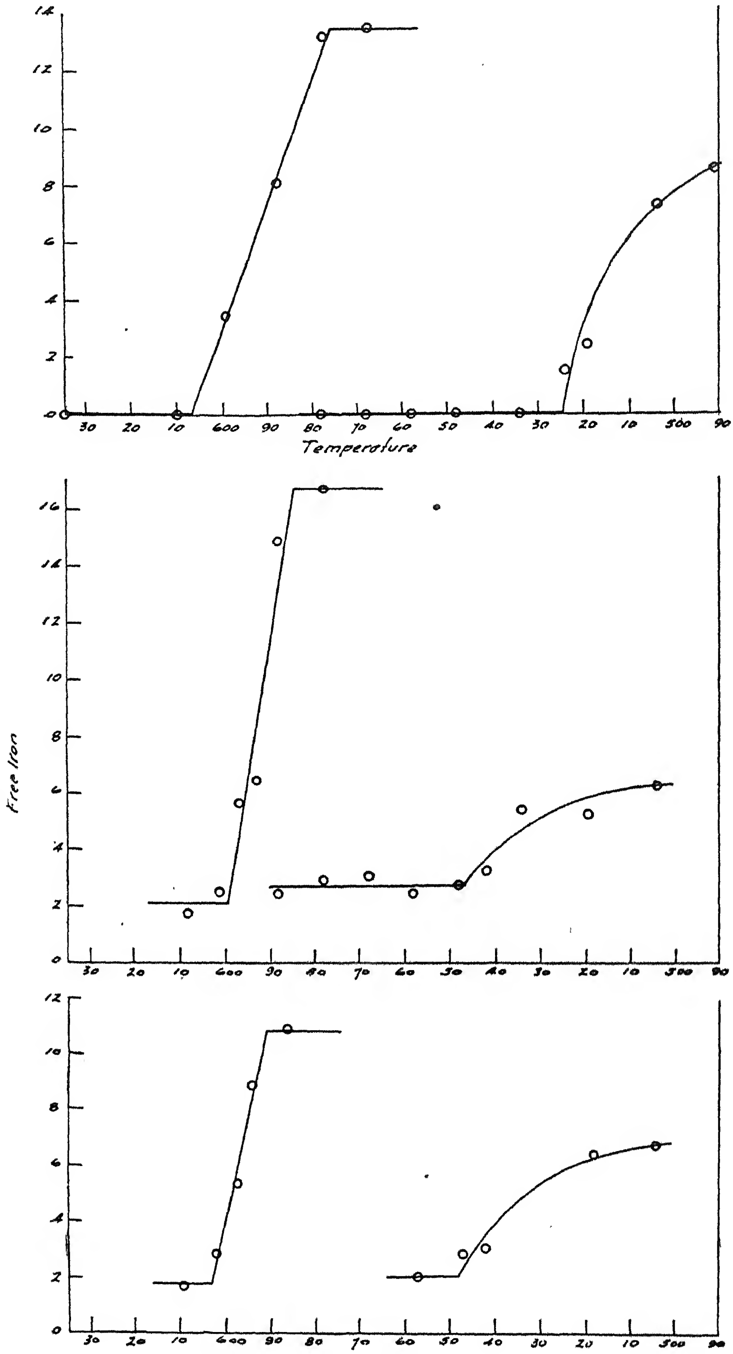

Fig. 1.

ferro-ferric oxide phase and vapor in the system, (Fe-O). Analyses of these samples are given in table II.

The free iron was determined by the copper sulfate method.[9] The ferrous iron reported was the value obtained by titration corrected for the metallic iron present. The ferric oxide was obtained by difference.

Each of these samples was divided into two parts. One part was kept and the other part was heated at a low temperature in vacuum until it contained an appreciable amount of free iron. We shall refer to this latter part as the converted part. Portions of each kind of material were then heated in vacuum in sealed pyrex glass tubes for five hours at carefully regulated temperatures. The free iron in each portion was then determined. The results are shown graphically in figure I. The graphs represent in order samples I, II, and III. The right hand curves were obtained with the original materials.

If all the ferrous oxide in samples I and II were converted to free iron and magnetic oxide, the resultant free iron content would be, respectively, 13.3 and 16.7 per cent. This calculation assumes the equation $4\ FeO \rightleftharpoons Fe + Fe_3O_4$. We were able to obtain conversions of 13.5 and 16.9 per cent iron and this is as good a check as one could expect from such materials.

With sample I, but one reaction appears to take place. Iron does not begin to form in the iron-free material until a temperature of 526°C. is reached. The iron in the converted part begins to combine at 577°C. and the reaction proceeds until all the free iron has combined.

With samples II and III, there appears to be an additional reaction by means of which a small quantity of iron is liberated. This may be noted even above 600°C. and the quantity of iron so formed does not appear to vary much in the temperature interval between this temperature and the temperature at which the major reaction takes place. The iron liberated in this reaction does not recombine when the converted materials are heated at the higher temperatures and the major reaction takes place.

Hilpert could not tell whether the compositions richer in ferrous oxide were unstable at the lower temperatures, or whether they were stable but could not be prepared owing to the slow reaction velocity. Our experiments indicate that they are not stable. It seems probable that ferrous oxide in the pure state is unstable at a fairly high temperature but that by the solution of ferro-ferric oxide the temperature of transition is lowered. The rates at which iron would form on cooling

[9] Williams and Anderson, *Journ. Ind. Eng. Chem.* 14: 1057. 1922.

ferrous oxide charges are such that its formation may have been a disturbing factor in Hilpert's work. The compositions of his iron-free ferrous oxide phases are probably richer in ferric iron than the phases which would be stable and in equilibrium with metallic iron at the various temperatures.

According to the hypothesis just advanced, the ferrous oxide solution saturated with ferro-ferric oxide would be the only one which would not partially decompose at temperatures above the invariant point. Matsubara's experiments indicate that in the range 863°–1175°C. the solubility is practically independent of the temperature. His saturated solution contains a little less than 76 per cent total iron. Sample I, which behaves as one would expect the saturated solution to do, contains 76.03 per cent iron.

The temperature of the invariant point must lie below 577°C. and above 526°C. Probably it lies much closer to the upper temperature rather than to the lower. More will be said regarding these temperatures later.

TABLE III.—EXPERIMENTS TO DETERMINE THE EQUILIBRIUM CONSTANT AT 750°C.

INITIAL MATERIAL	TIME HOURS	RATIO H_2O/H_2	IRON CONTENT PRODUCT	REMARKS
Pure iron	6	0.476	99.98	No oxidation
Pure iron	6	0.540	99.90	Oxidation slight if any
Pure iron	6	0.568	98.0	Oxidation started
			98.8	Analyses from different parts of the boat
Pure iron	6	0.595	93.6	More oxidation

III. THE EQUILIBRIUM CONSTANTS

A series of experiments was carried out at 750°C. and atmospheric pressure with the view of checking by the stream method the diverse values which have been obtained for the equilibrium constant by static methods. A similar apparatus to that used for the iron phase investigation was employed. Blank experiments were carried out in order to test the apparatus and method. The results are given in Table III.

These results indicate that oxidation starts with a mixture having a ratio probably slightly less than 0.54 and certainly less than 0.57. Chaudron's latest work leads to a value of 0.53 for this temperature. Eastman's calculated value would be 0.441. That of Schriener and Grimnes would be approximately 0.66.

Eastman has collected all the results to date on this equilibrium constant for various temperatures. A study of his graph of these shows that the results of Schriener and Grimnes give for the invariant point[10] a temperature of 636°C. Our work places this temperature below 577°C. and furnishes additional evidence that the constants of these workers are too large. It does not indicate, unfortunately, whether the values of Chaudron or of Eastman are to be preferred since one places the invariant point at 570° while the other gives it a value of 565°C.

Our stream method experiments give an upper limit for the constant. Since Chaudron was able to obtain good agreement between oxidation and reduction experiments at 785°C., we think that our value, which agrees with his, must be not far from the true value for the particular temperature.

The discrepancy between this value and that calculated by Eastman from the constants of the (CO_1CO_2,Fe,FeO) system arises from the fact that he gave great weight to the work of Matsubara. Chaudron's results on the two systems are in excellent agreement at 785°C. as evidenced by the fact that from them he obtained a value for the constant of the water-gas reaction of 0.87, Haber's value for this being 0.86. In view of this, one is somewhat at a loss as to how to interpret these results of Matsubara. Perhaps his iron phase was not the same as that found by us in the other system. His conclusion, that the iron phase contains much ferrous oxide in solution, though the most obvious one, is not the only possible explanation of his results and would seem to be in marked conflict with our own observations.

SUMMARY

1. The iron phase in the system (H_2,H_2O,Fe,FeO) does not contain appreciable quantities of oxygen.

2. The transition temperature of the ferrous oxide phase appears to be lowered by solution of ferro-ferric oxide in the ferrous oxide, The quadruple point lies below 577°C.

3. A value for the equilibrium constant at 750°C. was obtained by the stream method. It agrees with the value obtained by the interpolation from the results of Chaudron and furnishes a check on the latter.

[10] The temperature of the quadruple point in the system (Fe, O,H) may be considered for our purpose as identical with that of the invariant point in the system (Fe, O).

MINERALOGY.—*Methods for distinguishing natural from cultivated pearls.*[1] F. E. WRIGHT, Geophysical Laboratory.

Efforts have been made for several centuries to induce pearl-growing oysters and mussels to produce pearls comparable in quality and size to the "natural" or " normal" pearls found by pearl divers in different parts of the world and known to the trade as fine pearls. It is a simple matter to provoke formation of "blisters" and baroque pearls, but only recently has a Japanese, Dr. K. Mikimoto, succeeded in developing a suitable method for inducing pearl oysters to grow pearls which are spherical in shape and similar in external appearance to fine pearls. His process, which has been patented, is essentially the following: A pearl oyster is first removed from its shell; from its outer, shell-secreting mantle, a patch is dissected off, large enough to enclose, as a sac tied at the neck, a foreign nucleus, such as a bead of mother-of-pearl or even an inferior pearl. Each bead thus enveloped by the shell-secreting epidermis is embedded in the sub-epidermal tissues of another live oyster, which, after proper treatment of the wound, is returned to its native habitat where in the course of a few years a coating of pearl around the inserted bead may be deposited. The success of this process is due, as was first emphasized by Dr. H. Lyster Jameson,[2] to the "presence, in the sub-epidermal tissues of the oyster, of a closed sac of the shell-secreting epidermis and not to the presence of an irritating foreign body" as has been often supposed.

The pearls thus induced by the Mikimoto process are now on the market and pearl merchants have had difficulty in distinguishing natural Japanese pearls from the cultivated pearls of Mikimoto.

A short time ago the writer's interest in this problem was aroused by Dr. G. F. Kunz of New York who kindly loaned him, for examination and comparison, examples of the Japanese cultivated pearls and of fine pearls. In the Japanese pearls the centers were without exception mother-of-pearl beads, and the methods described below are based in large part on the ability of the observer to recognize the mother-of-pearl nucleus.

Mother-of-pearl or nacre substance is composed of alternate laminae or layers of calcium carbonate and of a horny organic substance called conchiolin. In most of the mother-of-pearl shells examined by the writer the carbonate is the mineral aragonite in the form of needles elongated parallel with the acute bisectrix and oriented perpendicular

[1] Received June 19, 1923.

[2] Proc. Zool. Soc., I, 140–166. 1902; Nature, Jan. 22, 1903, p. 280; Nature, May 26, 1921, p. 397.

to the pearly layers. The iridescence (luster, orient) of the pearl is due to interference of waves of light at the different pearly layers[3] which are remarkably uniform in thickness; the combined thickness of the carbonate layer and the conchiolin layer is 0.0004 to 0.0006 mm. or about equal to a wave length of light. At the surface of each layer some light is reflected and this interferes with a certain part of the incident light. The final result is the reflection of a relatively large amount of light and a correspondingly low transmission of the mother-of-pearl for rays of light incident normal to the pearly surface. The reflecting power on sections normal to the layers is appreciably less and the transmission is relatively much higher. This difference in reflecting power and in transparency with direction is easily seen on a bead of mother-of-pearl. Held in one position the characteristic pearly luster appears; turned through 90° the luster is less and the bead is noticeably more transparent. In strong sunlight this difference is still more striking. If now the bead of mother-of-pearl is enclosed in concentric layers of pearly substance, the lack of transparency of these layers, especially when viewed along a diametral direction, tends to mask the mother-of-pearl phenomena; but if the cultivated pearl be viewed under proper conditions of illumination the phenomena characteristic of mother-of-pearl are readily seen.

1. *Test in reflected light.* To test a pearl by this method examine the pearl first in reflected light. Stand with the back to the window, to the sun, or to some strong source of light. Hold the pearl so that it is illuminated by rays from the rear and observe the change in intensity of reflected light as the pearl is rotated. This rotation is accomplished most readily if the pearl is mounted on a string or a piece of thin wire. At the position for which the characteristic mother-of-pearl sheen is reflected by the nacre-bead, this sheen is clearly visible shining out from inside the pearl (Fig. 1c). It appears again on rotation of the pearl through 180°. After a little practice the eye catches quickly this phenomenon. Its appearance, which adds to the interest of the pearl, brands the pearl definitely as a cultivated pearl with a mother-of-pearl center.

2. *Test in transmitted light.* The pearl is examined either in air or while immersed in a liquid, such as water; the purpose of the liquid is to reduce to a minimum the amount of light reflected at the surface and thus to render more easily visible any lack of

[3] Optics. Sir David Brewster, pp. 137–140. 1853: A. H. Pfund, *The colors of mother-of-pearl.* J. Franklin Inst., 453–464. 1917.

homogeneity within the pearl. As a rule the liquid is unnecessary and is rarely used because it may possibly stain the pearl. The method consists in sending a narrow beam of intense light into one side of the pearl and noting any differences in illumination, along different directions in the opposite half, which are due to a foreign nucleus such as as a mother-of-pearl bead. Adequate illumination is attained by imaging on the pearl an intense light source, such as a pointolite bulb or a small arc or the sun, with the aid of a condensing lens

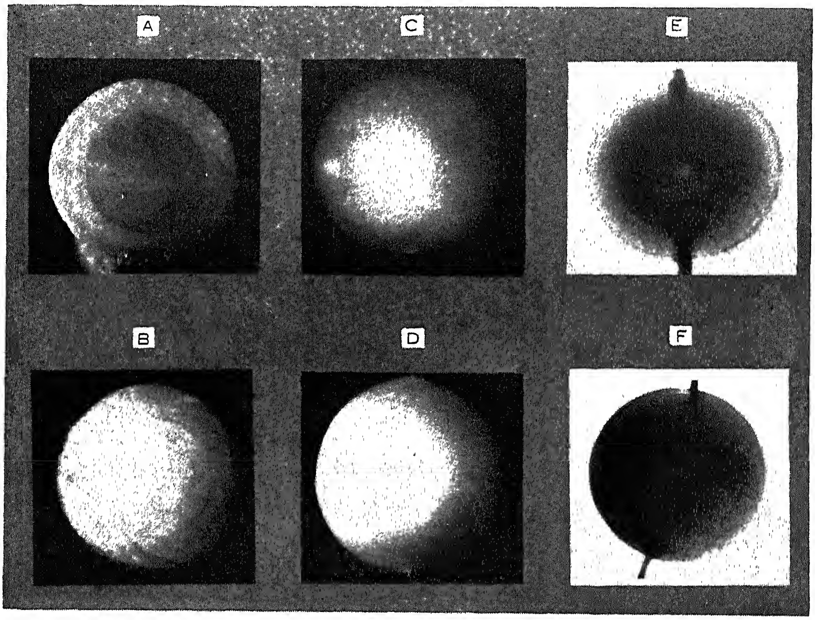

Fig. 1. *A*. Diametral section of cultivated pearl showing mother-of-pearl bead illuminated from the side. Magnification 5×. *B*. Section of the same pearl viewed in reflected light. *C*. Cultivated pearl viewed in reflected light showing on the left the illuminated spot due to the mother-of-pearl sheen. *D*. Natural pearl illuminated from the side. *E*. Cultivated pearl illuminated by strong light from the rear. *F*. Natural pearl photographed under the same conditions of illumination.

(Fig. 2). If possible a vertical beam of light travelling upward is used. To avoid extraneous light, the pearl is placed on a thin sheet of metal directly over a small hole (*c* Fig. 2) drilled through the metal. The hole serves as an aperture, somewhat smaller in diameter than the pearl.[4] The intense beam of light passes through the aperture, impinges on the pearl, and illuminates its interior. The only light that reaches the

[4] A special piece of apparatus for the testing of pearls by this method is now being made available by the Bausch and Lomb Optical Company of Rochester, New York.

observer is that which passes throught the pearl. Any differences in degree of transmission between center and periphery of the pearl are then clearly visible and enable the observer to see the shadow of any foreign nucleus. If the nucleus consists of mother-of-pearl the transparency differences for different directions of transmission through the bead can be observed on rotating the pearl. In natural pearls the central part appears opaque because of the high reflecting power normal to the concentric lamellae; but this central disk is not so large as the bead of a cultivated pearl and does not change its appearance as the pearl is rotated.

Under these conditions of illumination the pearl can be examined by the observer looking at it from any direction, either facing the source of light or at right angles to the incident beam or from any

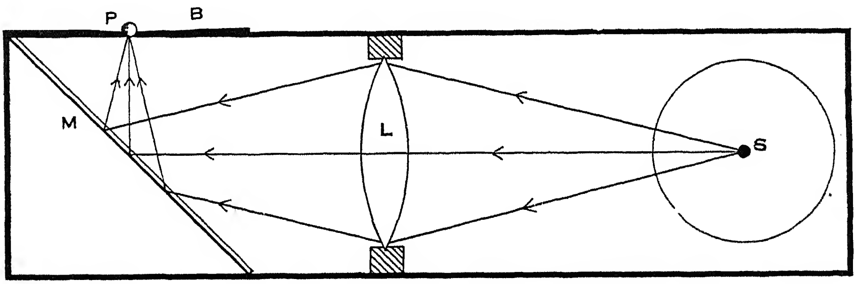

Fig. 2. Simple device for distinguishing cultivated pearls from natural pearls. *S.* strong point source of light; *L.* aspheric condenser lens; *R.* reflecting mirror; *B.* metal plate in which a small hole 3 mm. diameter has been drilled. Above this aperture, which can be made of different size by means of a sliding stop diaphragm, the pearl, *P*, rests.

intermediate position (Fig. 1, e.f). It is advantageous thus to examine the pearl end on and from the side because, as it is turned about, certain differences in homogeneity are more readily seen along one direction than another. Under these conditions any flaws or imperfections in the pearl, whether natural or cultivated, are clearly shown. Cultivated pearls exhibit many imperfections and patches of different reflecting power and degree of transparency. Many natural pearls show minute spots and irregularities, but the best pearls are free from flaws of any kind.

3. *Examination of the walls of the hole drilled through the pearl.* Illuminated by a strong beam of light from the side, the walls of the hole drilled through the pearl exhibit the boundary between the outer pearl substance and the mother-of-pearl nucleus. This is rendered visible not only by a difference in intensity of illumination but also in color; the pearl shells are noticeably blue in color while the nucleus

is tinted yellow. In this examination the pearl is supported on a wire extending into the hole to the center of the pearl. The wire is held between the thumb and first finger in an upright position and the hole is examined with the aid either of a magnifying glass, a microscope, or a binocular microscope. The work of Galibourg and Ryziger[5] has demonstrated that with the aid of a microscope and a suitable mirror it is possible to detect differences in homogeneity of the material exposed along the hole drilled through the pearl. The mirror, which they employ, is the top of a mercury column, like that in a thermometer tube. The mercury is forced up through the hole in the pearl by a delicately adjusted apparatus and the reflections from the top of the mercury column are observed through a strong magnifying system (microscope or binocular). This method is said to be very successful. The pearl is illuminated by a strong light from the side. The difference between the darker center and the enclosing pearl shell, especially at the boundary between the two, is clearly shown in the curved mirror. In applying this method, the writer has had difficulty in obtaining a uniform movement of the mercury column because of the capillary dimension of the hole and the tendency for slight obstructons to bar temporarily the passage of the mercury; in passing an obstruction, the mercury tends to flow rapidly and to advance by jumps rather than smoothly. The apparatus moreover is complicated and for purposes of this sort the handling of mercury is rarely satisfactory.

The following simpler and equally efficient method may serve the same purpose. In place of the mercury column a small bead fused on the end of a pure gold wire is used. A short piece of fine gold wire (0.2 mm. diameter and about 1 cm. long) is satisfactory; the bead is produced by holding the end of the wire in a Bunsen flame for a time sufficient to melt down the tip and form a small bead. The gold bead thus produced is much smoother and presents a more perfect reflecting surface than does a silver or platinum wire bead, or the surface which can be formed by grinding and burnishing the end of a fine steel needle in a lathe. The gold bead can be silver plated if desired. In the writer's experience, however, this is unnecessary. The wire is held stationary in a vertical position with the bead uppermost between the thumb and forefinger, the pearl to be examined is held by the other hand and slid over the stationary wire so that the wire passes through the drilled hole. If desired, the wire and also the pearl can be held by mechanical device and the pearl moved up or down by a screw. The pearl is illuminated by a strong light from the side. During this

[5] The Watchmaker, Jeweler, Silversmith and Optician, pp. 1821–1823. 1922.

operation the reflections from the stationary bead are observed through a low power microscope or binocular magnifying 25 to 50 diameters. The various phenomena described by Galibourg-Ryziger are shown equally well by this method. The preparation of beads of different sizes to fit different holes is a matter of only a few minutes.

This method has the advantage over the first two methods in that it may be used to distinguish between normal pearls and cultivated pearls with a pearl center.

In any case, test by all three methods should be applied, the one to serve as a check on the other. These tests are not time-consuming and in most instances lead to definite results.

4. *Test in ultraviolet light.* Recently C. S. Fox (Journ. Indian Industries and Labor, 1[3]: 235; Chemical News, **125**, 67–68. 1922) has found that in ultraviolet light both natural and cultivated pearls fluoresce, with the difference, however, that the Persian Gulf pearls are opaque to ultraviolet light whereas Japanese pearls, both natural and cultivated, have a translucent opalescence. He considers that because the cultivated pearl has a nucleus which comprises from 0.5 to 0.9 of the total volume of the pearl and which is of inferior material (mother-of-pearl) whereas a natural pearl is made up of concentric layers of pearly substance from center to periphery, the cultivated pearl is an inferior article and is not to be considered in the class with natural pearls. In view of the difficulty in distinguishing cultivated pearls from natural pearls, he proposes that all Japanese pearls, both natural and cultivated, which show a translucent opalescence in ultraviolet light, shall be considered of inferior quality. The writer has repeated the test of Fox with the new fluorescent microscope of the Bausch and Lomb Optical Company and has noted that the translucent opalescence described by Fox is not so clearly and distinctly shown that uncertainty may not arise regarding the kind of pearl under test, whether Indian or Japanese. It would seem unwise to adopt this suggestion because pearls may at some future time be cultivated in the waters of the Persian Gulf and then the rule would fail to accomplish the desired result, and produce confusion worse than ever.

BOTANY.—*A new genus of senecioid composites.* P. A. RYDBERG, New York Botanical Garden. (Communicated by PAUL C. STANDLEY.)

The genus *Clappia,* named after Dr. A. Clapp of New Albany, Indiana, was described by Dr. Gray in the Botany of the Mexican Boundary Survey. Dr. Gray placed the genus in the tribe Helenieae,

but thought that it might be referred to the subtribe Tagetineae. In the Synoptical Flora he transferred it to the subtribe Jaumieae, and was followed by Hoffman in Engler and Prantl's Natürlichen Pflanzenfamilien. When I prepared the manuscript of that subtribe for the North American Flora I was not so well acquainted with the variations displayed in the subtribe Tagetineae, and let it remain in the position given by Gray and Hoffman, though I felt that it was out of place. The bracts of the involucre are striate by black ducts which evidently are to be regarded as elongated resin glands. Such black markings, though very short, are found also on the leaves, especially the reduced upper ones. It is now evident to me that the genus should be transferred to the tribe Tageteae. The other genera of Jaumeanae lack this resinous striation as well as the fimbrillae on the receptacle.

The type of the genus, collected by Berlandier at Laredo, Texas, is rather unsatisfactory, being mostly out of flower, but Hooker illustrated it in his Icones (*pl. 1105*) from better material. The plant was reported by Gray as collected by Havard along the Pecos River and it was found by Rose at Brownsville in 1913 (*no. 18096*). The latter specimens show the characters of the genus very well.

Clappia suaedaefolia was also reported by Wooton and Standley in their Flora of New Mexico,[1] but the specimens on which this record was based do not belong to it and I suspect that it may be the case with Havard's specimens mentioned above. If Wooton and Standley's material is compared with type of *Clappia* or with Rose's specimens of the same, it is evident that the resemblance is only superficial and consists only in the same general habit, and that the former does not even belong to the genus *Clappia*. I was inclined to refer the specimens to the genus *Senecio*, but Dr. Greenman, who knows that genus much better than myself, was not willing to include them and I therefore propose the following new genus.

Pseudoclappia Rydberg, gen. nov.

Shrubs with glabrous, straw-colored or white branches. Leaves linear, subterete, fleshy, alternate or subopposite. Heads radiate, solitary, peduncled, terminating the branches. Involucre turbinate, without caliculum; bracts about 9, linear, somewhat fleshy, in 2 subequal series. Receptacle naked, alveolate. Ray-flowers 4 or 5, the ligules linear-oblong, 5–7-nerved. Disk flowers about 15, the tube narrow, shorter than and grading into the narrowly somewhat funnelform throat, the 5 lobes short, deltoid. Anthers with deltoid tips. Style-branches subulate-filiform, minutely hairy. Achenes prismatic, 5-ribbed, hispidulous. Pappus of numerous stiff bristles.

[1] Contr. U. S. Nat. Herb. **19**: 719. 1915.

Pseudoclappia arenaria Rydberg, sp. nov.

Clappia suaedaefolia Woot. & Standl. Contr. U. S. Nat. Herb. **19**:719. 1915. Not *C. suaedaefolia* A. Gray. 1859.

A low shrub; leaves linear, 1–3.5 cm. long, 1–2 mm. thick; peduncles 2–4 cm. long, with a few scalelike subulate small leaves; involucral bracts glabrous, linear, acute, 8–10 mm. long; ligules yellow, 6–8 mm. long, 2–2.5 mm. wide; disk-corollas about 1 cm. long; achenes blackish, prismatic, 3 mm. long, 1 mm. thick.

NEW MEXICO: White Sands, Otero County, July 20, 1901, *Wooton* (type; U. S. Nat. Herb. no. 739956); Aug. 31, 1904, Wooton *2618;* June 21, 1895, *Wooton.* White Sands, Dona Ana County, July 19, 1897, *Wooton 483.* South Spring, May 2–4, 1903, *Griffiths 4243* (U. S. Nat. Herb. no. *496288,* in part).

The plant can not be included in *Clappia* since it lacks the resinous striation of the bracts and the fimbrillae on the receptacle, and the bristles of the pappus are neither flattened nor paleaceous at the base. It can not be included in *Senecio* since the involucre is without caliculum and its bracts of a different texture, the pappus-bristles are stiffer than is usual in that genus, and the style-branches are distinctly Vernonioid, neither truncate nor with a hair-pencil at the end. The genus should, however, be referred to the tribe Senecioneae, subtribe Senecionanae, notwithstanding the Vernonioid style. A more or less vernonioid style is found also in the genera *Gynura, Emilia,* and *Psacalium.*

BOTANY.—Calderonia *and* Exandra, *two new genera of the family Rubiaceae.* By PAUL C. STANDLEY, U. S. NATIONAL MUSEUM.[1]

During a botanical collecting trip to the Republic of Salvador in 1921–22 the writer obtained imperfect material of two trees of the family Rubiaceae, both of which prove to represent undescribed genera. Both of them had been obtained by earlier collectors, and specimens existed in the National Herbarium, but the early material was too incomplete for satisfactory identification and has remained undetermined until now.

Of the two genera here described the more interesting and better defined is *Calderonia,* of which a complete series of specimens, showing both flowers and fruit from the same tree, has been collected by Dr. Salvador Calderón, of the Chemical Laboratories of the Salvadorean Department of Agriculture. Dr. Calderón is an enthusiastic student of botany and entomology, and has presented to the National Museum an unusually interesting collection of Salvadorean plants, beautifully prepared and consisting of over 1500 specimens, which are of exceptional value because of the vernacular names and full notes upon economic applications which accompany them.

[1] Published by permission of the Secretary of the Smithsonian Institution.

It is with a peculiar sense of pleasure and satisfaction that I am able to associate with one of the important trees of Salvador the name of a valued personal friend who is a true scientist in every sense of the word and who has done so much to make known the flora of one of the Central American countries of which practically no information was available previously. My pleasure in naming this genus is enhanced by the fact that it is thus possible to express, although very inadequately, an appreciation of the generous attentions and courtesies received from Dr. Calderón during a visit of five months to Salvador, attentions which contributed in a large measure toward making those months a delightful experience.

Calderonia Standl., gen. nov.

Trees, nearly glabrous throughout. Leaves opposite, petiolate, large, thin, deciduous. Stipules large, interpetiolar, caducous. Inflorescence terminal, the flowers small, cymose-paniculate, bracteate and bracteolate, sessile or short-pedicellate; hypanthium clavate, terete; calyx very shallowly 5-lobate but ruptured by the expanding corolla, persistent; corolla fleshy-coriaceous, funnelform-campanulate, the tube short, campanulate, the 5 lobes oblong-ovate, obtuse, nearly equaling the tube, glabrous outside, pubescent within, recurved, valvate in bud. Stamens 5, alternate with the corolla lobes, inserted at the base of the tube; filaments stout, pubescent below, exserted; anthers oblong, obtuse, dorsifixed near the base, dehiscent by antrorse slits. Disk annular, fleshy. Ovary 2-celled; style stout, glabrous, exserted, the 2 branches clavate and angulate; ovules numerous, crowded, attached to the septum. Capsule globose, ligneous, 2-celled, loculicidally bivalvate from apex nearly to base, the septum also vertically dehiscent. Seeds numerous, large, horizontal, semiorbicular, compressed, terminating in a thin transparent wing as large as the body, the testa minutely reticulate; embryo large, the radicle minute, the cotyledons oval, thin; endosperm none.

Type species, *Calderonia salvadorensis* Standl.

Calderonia salvadorensis Standl., sp. nov.

A tree, 5–15 meters, high, the trunk slender, with smooth whitish bark; young branchlets minutely puberulent; stipules linear-lanceolate, long-attenuate, about 2 cm. long, glabrous; petioles slender, 2–3 cm. long, minutely puberulent; leaf blades elliptic to oval-elliptic or oblong-obovate, 12–24 cm. long, 5.5–12 cm. wide, acute or short-acuminate, somewhat narrowed to the rounded or emarginate base, thin, puberulent beneath along the nerves, in the axils of the main nerves barbate and domidiate (furnished with small shelters—for parasites?), elsewhere glabrous, the lateral nerves 10–12 pairs; panicles 8–15 cm. long, often leafy below, dense, many-flowered, the rachis minutely puberulent, the flowers mostly sessile; hypanthium glabrous, 3 mm. long; calyx 1.5 mm. long, the lobes rounded, minutely ciliolate; corolla 5 mm. long; filaments about equaling the corolla lobes, the anthers 2.5 mm. long; capsule slightly depressed, about 2 cm. in diameter, with numerous large pale lenticels; seeds (including the wing) about 15 mm. long and 6 mm. wide.

Type (a flowering specimen) in the U. S. National Herbarium, no. 1,151,718, taken from a tree planted in the street in front of the Santa Tecla Railway station, in San Salvador, Republic of Salvador, July, 1922, by Dr. Salvador Calderón (no. 761).

Additional specimens examined:

SALVADOR: San Salvador, December, 1922, *Calderón* 761 (fruiting specimens from the type tree). Tonacatepeque, Departamento de San Salvador, December, 1921, *Standley* 19499. Nahulingo, Departamento de Sonsonate, alt. 220 meters, March, 1922, *Standley* 22052. Sonsonate, alt. 220 meters, March 1922, *Standley* 22312.

GUATEMALA: Patalul, Departamento de Sololá, February, 1906, *Kellerman* 5986.

The genus *Calderonia* belongs to the tribe Condamineeae of the family Rubiaceae. In the key to the genera of this group published a few years ago by the writer,[2] it would run at once to *Picardaea*, a West Indian genus to which it is not closely related. *Calderonia* differs from *Condaminae* in its winged seeds; from *Chimarrhis* in its terminal inflorescence; and from *Rustia* in the dehiscence of the anthers. The absence of endosperm in the seed is probably an important character. The Salvadorean tree appears to represent an unusually well marked genus of the Rubiaceae.

Calderonia salvadorensis is known in Salvador by the vernacular names of *campeche*, *brasil*, and *palo colorado*, and at Sonsonate I was informed that the names *drago* and *sangre de chucho* ("dog's-blood") were applied to it. The names *palo colorado*, *drago*, and *sangre de chucho* doubtless allude to the fact that all parts of the plant quickly assume a reddish tint when cut. This is particularly noticeable in the wood, but the leaves also are often affected the same way in drying.

The wood is said to be of good quality and is employed for building purposes and for firewood. By its peculiar color it is easily recognized. This red coloration is a property of other woods produced by trees of the same family, as, for instance, *Genipa maxonii* Standl., of Panama. Dr. Calderón in a recent letter says: "Lately I saw the wood used for rafters in a country house being built near Sonsonate, and in a building under construction in that city. Some time ago on the shore of Lake Ilopango, at a locality known as Apulo, I saw a large quantity of sawed timbers at least 45 cm. wide and 7 meters long or more, of pink wood, to which the name of *quina* was given. I do not know whether the tree from which they were obtained was the same as my No. 761, but the appearance of the wood was identical. The trees which I have seen are smaller, but in the wild state it would not be strange to find them large enough to give lumber of the dimensions I have described." The name *quina* ("quinine"), it may be remarked, is one often given in Salvador and elsewhere in Central America to Rubiaceous trees because their bitter bark is employed locally in place of the imported quinine.

The tree, Dr. Calderón states, is common in the fincas about San Salvador,

[2] N. Amer. Fl. **32**: 4. 1918.

being grown from seeds brought from the forests of the Department of La Libertad, where it is native. I saw many of the trees planted along the roads in the neighborhood of Sonsonate, and a fine large one in a finca at Tonacatepeque.

Exandra Standl., gen. nov.

Shrubs or trees. Leaves opposite, petiolate, the blades large, thin. Stipules interpetiolar, caducous. Inflorescence terminal, the flowers small, numerous, in paniculate cymes, sessile or short-pedicellate, bracteate and bracteolate; hypanthium clavate, somewhat obcompressed; calyx short, persistent, irregularly 5 or 6-lobate, the lobes triangular, obtuse or acute, thin, about equaling the tube; corolla shortly and broadly funnelform, glabrous within and without, open in bud, the tube broadly obconic, the 5 or 6 lobes nearly obsolete, broadly rounded, recurved in anthesis. Stamens 5 or 6, inserted at the middle of the corolla tube, alternate with the lobes, the filaments stout, long-exserted, pubescent below; anthers oblong, obtuse, dorsifixed near the base, dehiscent by lateral slits. Disk annular, shallowly lobate. Ovary 2-celled; style stout, nearly equaling the stamens, glabrous, deeply bilobate, the lobes oblong, obtuse; ovules numerous.

Type species, *Exandra rhodoclada* Standl.

Exandra rhodoclada Standl., sp. nov.

A shrub or tree, the young branchlets minutely puberulent; stipules about 2 cm. long, attenuate, puberulent; petioles slender, 2.5–4 cm. long, subterete, minutely puberulent; leaf blades rounded-ovate or rounded-oval, broadest near the middle, 20–30 cm. long, 16–25 cm. wide, short-acute or acuminate at apex, often somewhat abruptly so, slightly narrowed below and at base shallowly or deeply cordate, thin, glabrous except beneath upon the nerves, there minutely puberulent, the costa slender and salient beneath, the lateral nerves about 11 pairs; panicles short-pedunculate, dense, about 9 cm. long, pyramidal, the rachises fulvous-puberulent; bracts and bractlets lanceolate to triangular, small and deciduous; flowers mostly sessile; hypanthium puberulent, 3 mm. long; corolla 4–5 mm. long, 3.5–4 mm. broad; filaments 5–6 mm. long, the anthers 2 mm. long.

Type in the U. S. National Herbarium, no. 229232, collected between La Venta and Niltepec, Oaxaca, Mexico, altitude 60 meters, July 14, 1895, by E. W. Nelson (no. 2796).

Additional specimens examined:

SALVADOR: Comasagua, December, 1922, *Calderón* 1370. Finca Colima, in the Sierra de Apaneca, Departamento de Ahuachapán, January, 1922, *Standley* 20139.

The Mexican specimen is said to have been taken from a shrub or tree of 2.5 to 4.5 meters, with brownish and green flowers. Both the Salvadorean specimens are sterile but there is little doubt that they represent the same species. They were taken from trees, for which the vernacular names were given as *brasil* and *limpia-dientes*. Dr. Calderón reports that the tree yields lumber of good quality.

The systematic position of the proposed genus is doubtful because of the lack of fruit, but the writer has little hesitation in making the tree the type

of a new genus, since comparison with all the American genera of restricted groups of Rubiaceae, to one of which it must belong, shows that it can not be referred satisfactorily to any of them. The most noteworthy character is to be found in the estivation of the corolla, which is open in all the buds upon the single fertile specimen seen. It is probable, however, that the corolla lobes, theoretically at least, are imbricate in bud, which would make impossible the reference of the genus to the tribe Condamineeae, whose genera it resembles in general appearance. In its aspect it strongly suggsts *Calderonia*, to which the writer at first believed that it must belong, but the floral details of the two trees are quite distinct.

One of the striking features of *Exandra rhodoclada* is the red coloration assumed by the wood upon exposure to the air, a character which it shares with *Calderonia*. This coloration is perceptible also in the petioles and in the veins of the leaves after drying.

In connection with the descriptions of these two new genera there may be recorded the rediscovery of a plant described in this Journal[3] by myself a few years ago as a new genus of Rubiaceae, under the name *Blepharidium guatemalense*. The description was based upon a specimen collected in forest along the Saklak River below Secanquím, Alta Verapaz, Guatemala, in 1905 by Mr. H. Pittier. During May, 1922, I spent several weeks collecting about Quiriguá, Guatemala, and on the very first morning that I went out collecting this plant was found and recognized. It was seen several times in the vicinity, but the season was a little too early for obtaining good material, since at this time, the end of the dry season, the flowers were not fully developed. *Blepharidium guatemalense* is a shrub of two to three meters, with few branches and large (sometimes 45 cm. long), handsome, glossy leaves. It occurs sparingly upon the hills back of the hospital at Quiriguá at the edge of the pine forest with which their summits are clothed, growing in the dense thickets which are characteristic of the cohune (*Attalea cohune*) and pine ridges. The vegetation here bears a striking resemblance, both in general appearance and in composition, to that of the pinelands of southwestern Florida.

[3] **8**: 59. 1918.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

171ST MEETING

The 171st meeting of the ACADEMY was held jointly with the Philosophical Society of Washington in the Assembly Hall of the Cosmos Club the evening of Thursday, December 21, 1922. Dr. H. A. CLARK, Physicist of the Taylor Instrument Companies, Rochester, New York, delivered an address entitled, *The manufacture of thermometers.*

In the drawing of capillary tubing for thermometers, the workman fashions a mass of hot glass of approximately taffy-pulling consistency, on the end of a blowpipe. In this mass (12 to 16 inches long and 4 to 6 inches in diameter), the relative dimensions of the various parts in a cross section (such as the two diameters of an oval bore, if it is oval, and the various outside diameters if the tube is not cylindrical) are the same as in the completed tubing. It is then drawn mechanically to a length of about 180 feet, the final diameter depending upon various factors including rate of drawing.

To make a "chemical" thermometer, the workman starts with a piece of capillary cut to length, the area of bore of which has been carefully determined at both ends with a high power microscope. If it is to be a precision thermometer, the bore has, in addition, been calibrated with a mercury thread. A short piece of large-bore thin-walled tubing is sealed on for a bulb and its end drawn to a capillary through which mercury flows into the bulb, partly filling it, as it cools. The end of the bulb is sealed off, the mercury inside boiled to expel air, and the entire system now fills as it cools with the upper end of the stem under mercury.

The upper end is now sealed off with a large "false chamber" into which the bulb filling flows when bulb and stem are put into an electric oven for annealing, temperature being carefully controlled.

After annealing, excess mercury is driven into the false chamber and the stem is melted off just below, in such a way that the capillary space above the mercury column is evacuated or is filled with nitrogen, according to the range desired.

The "tube," so called, is now ready for a scale. For this purpose it is "pointed" by locating the mercury surface in the capillary at each of several known temperatures, by means of a fine scratch on the stem. To do this, the "tube" is immersed in well-stirred "baths" of various liquids, the temperature of each being determined with a standard thermometer. The temperature points chosen for pointing depend on the accuracy desired, as well as the range.

The tube is coated with wax and an automatic engraving-machine cuts the graduations, the spacing being automatically varied as required by the slight unavoidable non-uniformity of bore. Dipping into hydrofluoric acid, cleaning off acid and wax, and filling graduations with pigment make the thermometer finally complete.

The many other types of mercury-in-glass thermometers, clinical, industrial and others, pass through the above processes as well as others, depending upon the type. Still other types, consisting of liquid-in-metal bulbs and flexible metallic capillaries, much used in industry, cannot be here described for lack of space. (*Author's abstract.*)

172D MEETING

The 172d meeting of the ACADEMY, the 25th annual meeting, was held at the Administration Building of the Carnegie Institution of Washington the evening of Tuesday, January 9, 1923. The meeting was called to order by Vice-President CRITTENDEN, who called upon the retiring President, W. J. HUMPHREYS, to give his address entitled, *The murmur of the forest and the roar of the mountain.* This has since been published in the Journal of the Academy (**13**:49–64. February 19, 1923).

Following a brief intermission after the address, the annual business meeting of the Academy was held. The minutes of the 24th annual meeting were read and approved. The Corresponding Secretary, FRANCIS B. SILSBEE, reported briefly on the activities of the Academy during the year. On January 1, 1923, the membership consisted of 6 honorary members, 3 patrons, and 563 members, one of whom was a life member. The total membership was 572, of whom 355 reside in or near the District of Columbia, 201 in other parts of the United States, and 7 in foreign countries. Thirteen resignations were accepted during the year, of which two were of resident members, and the Academy lost by death the following members: CHARLES BASKERVILLE, ALEXANDER GRAHAM BELL, EDWARD K. DUNHAM, WILLIAM FREAR, HENRY MARION HOWE, CHARLES W. WAIDNER. During the year the Board of Managers held nine meetings. The decision of the Academy to discontinue the practice of attempting to print in the JOURNAL abstracts of scientific papers emanating from Washington was explained, the principal objections to the former custom being that the collection of abstracts was by no means complete, and that such abstracting service was better covered by special journals devoted to obtaining complete abstracts of all articles in their respective fields.

The report of the Recording Secretary, WILLIAM R. MAXON, was read. There were held during the year 9 public meetings, several of them jointly with one or more affiliated societies, at which illustrated addresses were delivered. The titles and dates and the places of publication of the addresses were stated.

The report of the Treasurer, R. L. FARIS, showed total receipts of $5,609.12, and total disbursements of $4,916.17; the cash balance in hand December 31, 1922, was $2,671.47. Investments of the Academy have a total par value of $15,036.37. The cost of maintaining and printing the Journal in 1922 was $3,579.26, a slight increase over 1921.

The report of the Auditing Committee, consisting of OSCAR S. ADAMS, E. F. MUELLER, and S. J. MAUCHLY was read, and the reports of the Treasurer and the Auditing Committee were accepted.

The report of the Editors of the Journal was read by SIDNEY PAIGE, the senior Editor. In general, the editorial policy of the Board had remained as in 1921, the changes made in composition and in size of page having been continued. Also, the cost of producing illustrations had been borne by the authors, as previously. Volume 12 consists of 486 pages, as against 537 published in Volume 11. Of original papers there were 52, one less than in 1921. The departments of Proceedings and Scientific Notes and News were maintained, but the publication of abstracts had been discontinued early in the year, as explained above.

The Committee of Tellers reported that the following officers had been elected for for 1923: *President,* T. WAYLAND VAUGHAN; *Non resident Vice-Presidents,* D. T. MCDOUGAL, W. F. G. SWANN; *Corresponding Secretary,*

F. B. SILSBEE; *Recording Secretary*, WILLIAM R. MAXON; *Treasurer*, R. L. FARIS; *Managers, Class of 1926*, H. L. SHANTZ, WILLIAM BOWIE.

The following Vice-Presidents, nominated by the affiliated societies, were then elected: *Archaeological Society*, A. H. CLARK; *Biological Society*, A. S. HITCHCOCK; *Botanical Society*, W. E. SAFFORD; *Chemical Society*, W. M. CLARK; *Institute of Electrical Engineers*, A. R. CHENEY; *Society of Engineers*, R. H. DALGLEISH; *Entomological Society*, S. A. ROHWER; *Society of Foresters*, G. B. SUDWORTH; *National Geographic Society*, FREDERICK V. COVILLE; *Geological Society*, W. C. ALDEN; *Medical Society*, L. H. REICHELDERFER; *Philosophical Society*, W. P. WHITE.

At 10:20 the meeting adjourned.

173D MEETING

The 173d meeting of the ACADEMY was held jointly with the Geological Society of Washington in the Assembly Hall of the Cosmos Club the evening of Wednesday, January 24, 1923. Dr. M. E. DE MARGERIE, Director of the Geological Survey of Alsace-Lorraine, delivered an illustrated address entitled, *The structure of the Alps.*

174TH MEETING

The 174th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club the evening of Thursday, February 15, 1923. Mr. W. D. COLLINS, of the U. S. Geological Survey, delivered an address entitled, *The industrial aspects of modern methods of water purification.*

Successful manufacturing is dependent on the chemical character of the water available for use in the various processes. The methods of water purification that are necessary for some supplies have a profound influence on the industrial value of the treated water. This has been the experience of many manufacturers who have been compelled to use water from a treated supply and attempt to duplicate the production of a plant using a water so free from mineral matter and organic pollution that it required no treatment.

The development of industry in the United States in the last fifty years has resulted in the movement of the center of industrial activity from New England, where pure water has been abundant, towards the middle west, where practically all the water available for public supplies requires purification. The demand for larger and larger supplies which must be taken from surface sources and the increasing pollution of these surface sources make necessary more and more complicated methods of treatment. While the purification makes some waters better for industrial use than t ey were before treatment, there are many instances where the treatment necessary to make a water safe to drink renders it quite unsatisfactory for some industrial uses. Serious losses have resulted from seemingly insignificant causes, such as the well known "iodoform" odor in some chlorinated waters, or from the excess or deficiency of carbon dioxide resulting from treatment with alum or lime. The person responsible for the successful operation of a manufacturing plant where the chemical character of the water used has an effect on the product must watch carefully the operation of the water purification plant, if he is using the water from a public supply that is purified by one of the more complicated methods of treatment. (*Author's abstract.*)

175TH MEETING

The 175th meeting of the ACADEMY was held jointly with the Philosophical Society of Washington in the Assembly Hall of the Cosmos Club the evening of Saturday, March 10, 1923. Prof. A. SOMMERFELD of Munich, delivered an address on *Evidence for the theory of relativity afforded by atomic physics.*

Two branches of modern physics stand in the center of scientific interest, the theory of relativity and the theory of atomic structure. They came together, as the speaker showed in 1916, in the theory of the fine structure of certain spectral lines.

The theory of relativity (Einstein, 1905 and 1915) is a new foundation of our general notions of space, time, matter, and gravitation, based on observational facts. The mass of an electron, for example, as well as length, time, and energy, is dependent on the relative velocity of the electron with respect to the observer. The theory of atomic structure (Bohr, 1913) is based on the notion of the nuclear atom (Rutherford, 1911) and on the theory of quanta (Planck, 1900). The electrons revolve around the nucleus, like the planets in the solar system around the sun. In the simplest atoms of hydrogen and of ionized helium we have a Keplerian motion: one electron revolving around the nucleus. Bohr succeeded in computing the wave lengths of the spectral lines of these elements and in revealing the laws of spectra, widely different from the laws of the oscillations of the usual mechanical systems. The wave-lengths are given by the energy differences of the atom in its initial and final states.

According to the theory of quanta, a certain state of the atom corresponds to a certain number of electronic orbits, either circular or elliptical. In the helium line $\lambda = 4686$, e.g. the initial state of the atom corresponds to four different orbits, the final state to three. These four different initial orbits, as well as the three different final ones, have the same energy, according to the classical mechanics of Newton. Therefore, all the $4 \times 3 = 12$ transitions give the same energy difference and produce the same spectral line.

But Newton's mechanics are only a first approximation; the real mechanics are Einstein's. According to the relativistic increase of the electronic mass with increasing velocity, the energy of the four initial orbits is slightly different as well as the energy of the three final orbits. So we get 12 components very close together, of a so-called fine structure. The photographs taken by Paschen in 1916 are projected; they prove themselves to be in best agreement with the prediction of the theory.

Fine structure components of the same character occur in the X-ray spectra of all elements; they show that the same circular and elliptical orbits and the same relativistic increase in the mass of the electron occur in the inner parts of all elements. (*Author's abstract.*)

WILLIAM R. MAXON, *Recording Secretary.*

PHILOSOPHICAL SOCIETY OF WASHINGTON

883D MEETING

The 883rd meeting was held in the Cosmos Club Auditorium on Saturday, April 7, 1923. It was called to order at 8:15 p.m. by President WHITE with 42 persons in attendance.

Owing to some experiments with liquid hydrogen which were in preparation by Dr. KANOLT, the reading of minutes of previous meetings was deferred until later in the evening.

The first paper on *Liquid and solid hydrogen* was presented by Dr. C. W. KANOLT. The paper was discussed by Messrs. HEYL, PAWLING, LITTLEHALES, HAWKESWORTH, CHANEY, amd HUMPHREYS.

Author's abstract: Liquid hydrogen was first obtained by Dewar in England about 25 years ago, and since then it has been produced in several laboratories. Although the method employed is fairly simple in theory, there have been some practical difficulties involved. The purpose of the work at the Bureau of Standards has been, first to make it possible to obtain readily at the bureau fairly large quantities of liquid hyrogen for experimental purposes, and, second, to study the difficulties of the process in order to make it easier for other laboratories to produce the liquid.

The principal difficulty has resulted from the influence of small quantities of air in the hydrogen. The air is frozen in the hydrogen expansion valve and soon clogs it. A proportion of air too small to be found by ordinary methods of gas analysis may still be sufficient to produce clogging. However a new method of determining very small quantities of nitrogen, the most troublesome impurity, in hydrogen has been found, and this has greatly facilitated the investigation and elimination of sources of contamination. The hydrogen employed is generated electrolytically in the laboratory. The liquefier in use produces two liters of liquid per hour and little difficulty is now experienced in its operation.

Solid hydrogen can be obtained by evaporating the liquid in a partial vacuum produced by a pump of sufficiently large capacity, and as the vapor pressure at the freezing point is relatively high, this operation is not difficult.

Liquid hydrogen was exhibited at the meeting and with it air from the room was liquefied and frozen.

President WHITE made announcement of the meetings of the American Geophysical Union to be held at the Administration Building of the Carnegie Institution of Washington on April 17 to 19.

Captain N. H. HECK presented a paper on *The relation of seismology to geodesy and tides.* The paper was illustrated with lantern slides, and was discussed by Messrs. HUMPHREYS, L. H. ADAMS, and BOWIE.

Author's abstract: A brief introductory statement shows what is being done in the United States in the study of Seismology, and the relation of the Coast and Geodetic Survey, which is doing the principal work in geodesy and tides, to this subject.

The need for better instruments, operation, and time control is pointed out. The important cooperative earthquake investigation in California by the Carnegie Institution of Washington, the California Universities, the Geological Survey, and the Coast and Geodetic Survey has brought out the necessity for precise triangulation and levels in seismological work, to determine whether or not surface shifts have occurred. Observations in Japan and elsewhere show clearly that such work should be carried on in earthquake regions.

The possibility of such shifts along the coasts, due to submarine earthquakes, makes the observation of such earthquakes of special importance. The magnetic observatories of the United States, though placed entirely with regard to magnetic work, are exceptionally well located for the observation of submarine earthquakes, four of them being in regions where major earthquakes have occurred.

Submarine earthquakes are the cause of the so-called tidal waves, destructive nearby, and often causing long continued fluctuations at a distance. Tidal records of the Chilean earthquake tide and of the recent

tidal wave at Hilo, Hawaii, are of special interest. The automatic tide-guage records at twenty stations are now regularly examined for abnormalities due to earthquakes.

Possible relations between the theory of isostasy and earthquakes are pointed out. Isostasy indicates that earthquakes occur above the depth of compensation.

Dr. J. E. IVES presented a paper on *The nature of the illumination used by engravers of steel plates*. The paper was discussed by Mr. HAWKESWORTH.

Author's abstract: The engraver on steel works on highly polished steel plates which are used in the printing of pictures, postage and revenue stamps, paper money, certificates of stock and bonds. Since the lines cut into the steel are visible only by the shadows cast by the edges of their grooves or depressions, or because their surfaces are inclined at such angles that they are in shadow or do not reflect light falling upon them, the best results are obtained by using an illumination which is diffuse with a predominating direction downwards and towards the worker, and which produces a uniform, or nearly uniform, brightness of the whole surface of the plate. This is, in practice, obtained by using a screen of translucent material such as tracing cloth, tracing paper, or tissue paper, placed between the source of the illumination, natural or artificial, and the plate, so that the image of the tracing cloth is reflected in the plate. The screen is usually about 30 inches square and inclined at an angle of about 45° to the plate. The reflected image of the illuminated tracing cloth makes the polished surface of the steel look like a sheet of white paper. On such a surface the lines cut into the steel can be clearly seen. If such a screen is not used there will, in general, be bright and dark areas on it, and where the surface is dark the lines cut into the surface cannot be seen. Also the contrast between the bright and dark areas on the plate produces more or less glare.

Measurements were made of the illumination on the plates, of the brightness of the screens, and of the brightness of the surface of the plates. Study of the results obtained leads to the conclusion that the brightness of the surface of the screen should be as uniform as possible. For natural illumination an uninterrupted north sky light is the best, and is much better than light from south windows, since the latter is very variable, varying from bright sunshine to cloudiness. If the screen is illuminated artificially by one or more electric lamps, the light from the lamps should be so arranged that it is spread uniformly over the screen. It was found that a non-uniform illumination of the screen produced discomfort in the eyes of the workers. Artificial illumination, besides being uniformly distributed over the screen, should also be of sufficient intensity.

The results recorded in this paper were obtained in connection with investigations on this subject made recently by the office of Industrial Hygiene and Sanitation of the U. S. Public Health Service.

884TH MEETING

The 884th meeting was held jointly with the Washington Academy of Sciences and the Chemical Society of Washington in the Auditorium of the Interior Building at 8:30 p.m. on Tuesday, April 17, 1923.

Papers were presented by Dr. F. G. DONNAN, Professor of Chemistry, University College, London, and by Dr. JAMES C. IRVINE, Principal and Vice-Chancellor, University of St. Andrews, on their own recent researches in chemistry.

885TH MEETING

The 885th meeting was held jointly with the Washington Academy of Sciences and the Geological Society of Washington in the Auditorium of the Interior Building at 8:15 p.m. on Wednesday, April 18, 1923.

The following papers on the Taylor-Wegener Hypothesis were presented:

(1) FRANK B. TAYLOR—*The lateral migration of land masses.*

(2) R. A. DALY—*A critical review of the hypothesis.*

(3) W. D. LAMBERT—*The mechanics of the hypothesis.*

After the completion of the third paper, the hour was so late that the fourth paper by F. E. WRIGHT on *Report of the symposium at the meeting of the British Association* was not called for.

J. P. AULT, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Dr. P. S. EPSTEIN, of the California Institute of Technology, lectured at the Bureau of Standards Physics Club, Saturday, June 2, on *The principle of correspondence or the relation of the quantum theory to classical mechanics.*

Messrs. A. H. BROOKS and T. WAYLAND VAUGHAN of the U. S. Geological Survey, and N. M. FENNEMAN of the National Research Council and H. E. GREGORY of Yale University, both associated with the Geological Survey, will attend the Pan-Pacific Congress in Australia in August as official delegates of the Government.

Dr. N. L. BOWEN, petrologist, of the Geophysical Laboratory, Carnegie Institution of Washington, is spending the summer studying the igneous rocks of England, Scotland, Norway, and Sweden.

Dr. F. C. COOK, of the Bureau of Chemistry, U. S. Department of Agriculture, died at Dallas, Texas, on June 19, 1923, in his forty-sixth year. He was born at Litchfield, Connecticut, July 14, 1877. Dr. Cook had been connected with the Bureau of Chemistry since 1903. His scientific studies and publications were concerned with metabolism, enzymes, insecticides, fungicides, etc. He was a member of the ACADEMY, American Chemical Society, and several local and foreign societies.

Mr. A. B. FATH has resigned from the U. S. Geological Survey and has joined the staff of the Vacuum Oil Company. He will be in Europe for the next few months.

Dr. ALES HRDLICKA, of the Department of Anthropology, U. S. National Museum, has sailed for Europe to take charge of a party of American scientists who will study during the summer the prehistoric remains in England, the Island of Jersey, France, Belgium, Germany, Czechoslovakia, and Croatia.

Dr. GEORGE M. KOBER, dean of the medical school of Georgetown University for the last thirty-two years, received the degree of doctor of letters at the 124th commencement exercises of the University on June 11.

Mr. E. S. LARSEN, Jr., has been appointed professor of petrography at Harvard University and will relinquish his work as chief of the section of petrography of the U. S. Geological Survey on September 1.

Mr. W. R. MAXON sailed from New York May 15 for the purpose of making botanical collections in Central America, in cooperation with the U. S. Department of Agriculture, which is sending an expedition for the investigation of the rubber resources of that region.

Dr. F. L. RANSOME, of the U. S. Geological Survey, has accepted an appointment as professor of geology and head of the department at the University of Arizona, Tucson, for the coming academic year. He has not severed his connection with the Geological Survey, and his stay in Arizona is indefinite.

Dr. B. COLEMAN RENICK, graduate of Chicago University and recently connected with the teaching staff of the University of Iowa, has been appointed assistant geologist in the ground water division of the U. S. Geological Survey and will begin work in Montana July 1.

Messrs. E. S. SHEPHERD and PAUL STOUTENBURGH, of the Geophysical Laboratory, Carnegie Institution of Washington, are making a chemical field study of differentiated igneous rocks in Montana and Utah during the summer months.

Dr. EDWARD WOLESENSKY has been appointed associate chemist on the investigation of synthetic tanning materials, at the U. S. Bureau of Standards, from June 11, 1923. He has recently been engaged in research and development work on dyes and intermediates and during the war did research work at the American University.

JOURNAL

OF THE

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GEOLOGY.—*Stratigraphy of the Virgin Islands of the United States and of Culebra and Vieques Islands, and notes on eastern Porto Rico.*[1] T. WAYLAND VAUGHAN, U. S. Geological Survey.

CONTENTS

INTRODUCTION

The present paper briefly summarizes some of the results obtained from a geologic reconnaissance I made of the islands of St. Croix, Saint John, Saint Thomas, Culebra, and Vieques and of the eastern

[1] Published by permission of the Acting Director of the U. S. Geological Survey. Received May 11, 1923.

end of Porto Rico in compliance with a request made by the Navy Department for special geologic information on the territory examined. The field work was done between May 21 and June 24, 1919. The collections made were examined by the following of my official colleagues: Mr. C. P. Ross examined the igneous rocks; Dr. T. W. Stanton identified the Cretaceous mollusks; Dr. J. A. Cushman identified the Tertiary Foraminifera; Dr. R. S. Bassler, the Bryozoa; and Dr. C. W. Cooke, the Tertiary Mollusca. The corals were identified by me.

LOCATION AND GENERAL FEATURES

The Virgin Islands, except Saint Croix and its outlying islets, rise above a shallow bank that extends northeastward from Porto Rico to Anegada Passage. The number of the islands is about 100. They are separated from one another and from eastern Porto Rico by water having a maximum depth of 16 to 18 fathoms. Except Anegada which rises only about 30 feet above sea level, the larger islands attain altitudes ranging from about 650 feet (Culebra) to 1800 feet (Tortola) in altitude. The highest point in Saint John is 1,277 feet; in Saint Thomas, 1,550 feet; in Culebra, 650 feet; in Vieques, 981 feet. The islands are well dissected and as a rule have gradual slopes, except along the shores where there may be high sea-cliffs. The absence of inland bluffs is one of the striking features of the topography of these islands. The shore line is indented by bays, which indicate geologically Recent submergence.

The Virgin Bank is about 90 sea miles long and from 24 to 30 sea miles wide. The depth of water on it is as much as about 40 fathoms around its edges where there are steep descents to deep water, to over 3,000 fathoms between Saint Thomas and Saint Croix, to about 1,200 fathoms in Anegada Passage, and to 400 fathoms on the north side, where there is an apparently gradual slope to depths of about 3,600 fathoms at a distance of about 55 sea miles north of the bank. Along a line about 25 sea miles long through the Virgin Passage the depth ranges from 12 fathoms in the shallowest part to about 40 fathoms on the northern edge—the range in relief on the flat being only about 132 feet in about 25 miles. The surface of the bank exhibits submarine terraces both off the shores of Saint John and Saint Thomas and in the Virgin Passage. The living coral reefs have grown up on the terraced surface of the bank after an episode of submergence, a relation which I have described in several papers.

Between the Virgin Bank and Saint Croix there is a deep of 3,400 fathoms which is continuous eastward into Anegada Passage, whose

depth is over 1,000 fathoms. The maximum altitude in Saint Croix is 1,164 feet, the top of Mount Eagle. The higher land is dissected and has gradual slopes similar to those mentioned for the islands on the Virgin Bank, but Saint Croix is peculiar in that in its southwestern part there is an extensive, gently sloping limestone plain. The shore line features are indicative of submergence as in the case of the other islands.

STRATIGRAPHY

In the Virgin Islands three major sets of rocks may be recognized as follows: (1) Upper Cretaceous sediments and interbedded volcanic tuffs, breccias, and lava flows; (2) Post-Cretaceous, probably early Tertiary, intrusive gabbro, dolerite, diorite, and quartz-diorite, and perhaps also volcanic extrusions; (3) Oligocene and Miocene marls and limestones.

Upper Cretaceous Rocks

Saint Croix

The older rocks of Saint Croix are exposed in the northwestern part of the island and they occupy the entire area east of Christiansted. They comprise sandstone, shale, and limestone, with interbedded volcanic tuffs. A very instructive exposure may be studied at Waiter's Point. On the east side of this point there are thinly bedded sandstone and shale, west of which is limestone interbedded with volcanic tuff. Quin published notes on the exposure at this place and collected Cretaceous fossils there, but he did not know the biologic affinities of the fossils or their geologic significance. The Misses Quin presented to me, for transfer to the United States National Museum, all of their father's collection and I collected an additional species. Dr. T. W. Stanton supplies the following list of species from Saint Croix:

Inoceramus sp., related to *I. proximus* Tuomey.
Barrettia monilifera Woodward.
Barrettia sparcilirata Whitfield?
Radiolites nicholasi Whitfield.
Caprinula gigantea Whitfield?
Caprinella occidentalis Whitfield.

There is no room for doubt as to the geologic age of the deposits from which these fossils come—it is Upper Cretaceous.

The interbedding of volcanic tuff with the limestone has been mentioned.

Saint Thomas

The presence of sediments of Upper Cretaceous age in Saint Thomas was first recognized by Cleve in 1869, when he collected a moderate number of fossils and recognized the affinities of the fauna with that of Gosau, Austria. Some years ago Professor A. G. Högbom of the University of Upsala lent me the Cleve collection and Doctor Stanton listed for me the genera of the fossils. They are as follows:

Glycymeris
Limopsis
Astarte, several species
Opis
Cyprina?
Corbula
Cerithium, two or more species
Nerinea, several species
Actaeonella
Phylloceras?, immature, septa not well shown.

It seems that I did not rediscover the precise spot at which Cleve obtained his specimens; however, I collected at Coki Point, one of the localities mentioned by Cleve, poorly preserved fossils that seem to represent the genera *Astarte*, *Glauconia*, *Cerithium*, and *Actaeonella*. The fauna is clearly the one discovered by Cleve. The fossils occur in very hard, blue, metamorphosed limestone. At a locality near Coki Point, limestone belonging to the same formation contains some volcanic material and is associated with, probably interbedded with, shaly rocks that have been metamorphosed into schists.

The principal country rock of Saint Thomas comprises andesitic breccia and latite, which in places shows rude bedding. I did not actually observe the relations of these rocks to the Cretaceous limestone, but the older volcanic rocks have been considerably metamorphosed. It is to rocks of this kind that the local name "blue-beach" is applied. Cleve says that he found north of Bucks Bay "blue-beache, black and sometimes metamorphosed clay slate, and flagstone, alternating;" and he says that near Coki Point the blue beach contains "calcareous nodules and marble of a white or gray color." The older volcanic rocks, therefore, seem to be of Upper Cretaceous age.

Saint John

Except large rounded, apparently water-worn boulders about half a mile east of Government House, Little Cruz Bay, the only rocks I saw on Saint John are clearly of igneous origin. The rocks at Coral Bay are chlorite and sericite schists and are inferred to be of Cretaceous or more ancient age, because of the metamorphism they have undergone. Cleve mentions greatly metamorphosed limestone at

Anna Bay (probably meaning Anna Berg). Although paleontologic evidence is not available for Saint John, the lithologic characters are such as to leave no reasonable doubt of the presence on it of both Cretaceous sedimentary and volcanic rocks as on Saint Thomas, which is only about one and a half miles from the west end of Saint John, and there may be rocks of pre-Cretaceous age.

Culebra

Metamorphosed sedimentary rocks composed of reworked volcanic constituents were seen in the valley north of San Ildefonso; southwest of Swell Bay at altitudes below 200 ft.; on the point of land on both the east and west sides of Surf Bay; west and north of Great Harbor; and at Playa Sardinos. On the basis of their lithologic characters it seems safe to refer these rocks to the Upper Cretaceous.

Vieques

The oldest rocks observed on Vieques comprise a trachytic lava flow, overlain by limestone conglomerate, over which is an altered basalt, which in turn is overlain by hard blue limestone. This exposure is at Punta Diablo. The dip of the limestone is as high as 60°. Bedded rock of shaly or sandy appearance, which is probably water-laid tuff, was seen at many places. Because of its lithologic characters, its deformation, and its metamorphism, this group of rocks is considered of Upper Cretaceous age.

Eastern Porto Rico

Examination was made of bedded sandstones and shales, which are composed of water-laid volcanic material, in the vicinity of Fajardo and of a folded basalt flow at Cape San Juan. These sediments and their associated igneous rocks, which are cut by great dikes of dolorite, would be referred to the Upper Cretaceous according to the criteria I have applied in Culebra and Vieques. They evidently represent what Hill described as "black or other dark-colored basic igneous rocks, occurring as tuffs, conglomerates, and sills of hornblende-andesite, cut by dikes of diorite."[2] Hill found associated with these rocks limestone in which he collected fossils that Dr. T. W. Stanton identifies as belonging to the Capriniidae and considers representative of the Upper Cretaceous. Berkey's[3] descriptions of the rocks exposed

[2] Hill, R. T., Notes on the forest conditions of Porto Rico: U. S. Dept. of Agriculture, Division of Forestry Bull. 25: 14–15. 1899.

[3] Berkey, C. P., Geological reconnaissance of Porto Rico: New York Acad. Sci. Ann. 26: 1–70. 1915.

around Fajardo are correct, but he gives no data of assistance in determining their geologic age.

Summary statement on Cretaceous rocks.—Fossiliferous Upper Cretaceous sediments interbedded with volcanic rocks occur in Saint Croix and Saint Thomas. Sediments with interbedded or associated volcanic rocks similar to those of Saint Croix and Saint Thomas are present in Saint John, Culebra, Vieqeus, and eastern Porto Rico, and because of similar lithology and similar deformational history are considered of Upper Cretaceous age.

Early Tertiary Events

Subsequent to the deposition of the Upper Cretaceous sediments and the extrusions of the associated volcanic rocks, there was intense deformation, which resulted in tight folding in Saint Croix, where dips of 80° or more are common; the dips in Saint John are about the same; in Saint Thomas they are 50° or more; in Culebra I noted some low dips, only 19°; in Vieques the dips are as much as 60°; in eastern Porto Rico the range is from about 13° to almost vertical. Some of the older igneous rocks, which in many instances have been so crushed that they are now chlorite or sericite schists, may be of pre-Cretaceous age. The structure lines cannot be described at this place—only the general statement may be made that in places there are intersecting trends, one approximately east and west and another from northwest to southeast. The two sets of trends are very clearly recognizable in Saint Thomas. There were extensive intrusions of diorite, dolerite, and quartz-diorite, and probably also extrusions of lavas and tuffs. Quartz-diorite is the dominant rock in Vieques. The older series of rocks was subjected to subaerial erosion for so long a time that over considerable areas they were practically base-leveled and the next younger sediments were laid down on a nearly plain surface developed on rocks that dip as steeply as 80°, as in the southwestern part of Saint Croix.

Tertiary Sediments

Sediments of Tertiary age are present in Saint Croix, Vieques, and eastern Porto Rico but appear to be entirely absent on Saint John, Saint Thomas, and Culebra. In fact, except Anegada, there are no known Tertiary sediments on the axial islands of the Virgin group, and in Porto Rico such younger deposits are confined to the northern and southern flanks of the island. Therefore the axial islands of the Virgin Bank and the sierras of Porto Rico appear to have been above water since the close of Cretaceous or since very early Tertiary time.

Saint Croix

In Saint Croix Tertiary limestones and marls cover an area reaching the southern shore south and southeast of the hills in the northwestern part of the island, they extend northward to the north shore just east of the mouth of Salt River, whence the eastern boundary runs southward to the west side of Waiters Point. In general the limestones are soft, rather crumbly, and there are interbedded layers of conglomerate. The dips are in general southward, at angles ranging from 8° to 15°—strongly contrasting with the steep dips, in places 80° or more, of the Cretaceous rocks.

Three horizons seem to be represented in these limestones, viz., (1) middle Oligocene, (2) probably upper Oligocene, (3) lower Miocene.

Middle Oligocene

Station 8649. Two-tenths of a mile southwest of Wheel of Fortune estate house; collection made on northern slope of a low hill.

Foraminifera:

- *Rotalia* sp. Abundant
- *Amphistegina* sp. Compare with station 8648.
- *Lepidocyclina morgani* Lemoine and R. Douvillé. Also Cuba.
- *Carpenteria americana* Cushman. Also Cuba.

Madreporaria:

- *Astrocoenia decaturensis* Vaughan. Also Antigua; Bainbridge, Ga.
- *Gomiastrea reussi* (Duncan). Also Antigua.
- *Cyathomorpha tenuis* (Duncan). Also Antigua; Pepino formation of Porto Rico; and other places.
- *Goniopora microscopica* (Duncan). Also Antigua.

Geologic correlation.—The organisms from this locality show clearly that the geologic horizon is the same as that of the Antigua formation of Antigua, for every coral well enough preserved for specific identification also occurs in Antigua, and that it is, therefore, middle Oligocene.

Probably upper Oligocene

Station 8647. One and four-tenths sea miles in a straight line from Christiansted lighthouse, on the south side of North Shore road at Evening Hill.

This is the locality at which Quin[4] says he found large Foraminifera. The rock as exposed in the road is an argillaceous limestone, mostly rather soft but there are indurated lumps and beds. The fossils comprise some well preserved nummulitoid Foraminifera and indetermin-

[4] Quin, John T., The building of an island, p. 17, 1907.

able fragments of corals. The names of the Foraminifera are as follows:

Amphistegina sp.
Heterostegina antillea Cushman. Also Antigua and northeastern Mexico.
Heterosteginoides sp. cf. *H. antillea* Cushman. Also Anguilla.

Station 8648. North Shore road, Montpellier (east).

The rock here exposed is a rather soft, spongy, impure limestone. The contained organic remains include determinable Foraminifera and indeterminable corals and mollusks. The geologic formation seems the same as that exposed at station 8647. The Foraminifera are as follows:

Amphistegina sp. Compare above, station 8647.
Peneroplis sp.
Gypsina globulus (Reuss). Also Anguilla; Recent.

Geologic correlation.—There seems to be no reasonable doubt that the same formation is exposed at both Evening Hill and on the North Shore road at Montpellier (east). The geologic horizon is either middle or upper Oligocene, more probably upper Oligocene.

Station 6850. Montpellier (east), collected by John T. Quin. The specimen referred to by Quin as a volute[5] is a species of *Orthaulax* which seems to be the same as a species of *Orthaulax* I collected at Crocus Bay, Anguilla, now identified as *O. aguadillensis* Maury. The specimen from Saint Croix was presented to me for transfer to the United States National Museum by the Misses Quin, the daughters of the author of "The building of an island," and I had a number of sections cut of the matrix. Foraminifera are abundant and Doctor Cushman furnishes the following list:

Alveolina sp. Also Saint Martin.
Orbitolites duplex Carpenter? Also Saint Martin.
Spiroloculina sp. Also Saint Martin.
Also indeterminable species of *Quinqueloculina*, *Triloculina*, *Globigerina*, and *Amphistegina*.

Geologic correlation.—The presence of the species of *Orthaulax* above noted suggests upper Oligocene, about the horizon of the Anguilla formation, as the age of the bed from which the specimen came. Doctor Cushman says that the Foraminifera are precisely the same as those I collected in the yellowish limestone of Saint Martin. The horizon may be very low Miocene instead of topmost Oligocene.

[5] Quin, John T., The building of an island, plate opposite page 16, 1907.

Miocene

Station 6851. Anna's Hope estate, along the road.

Foraminifera:

Clavulina sp. cf. *C. parisiensis* d'Orbigny. Also Culebra formation.
Clavulina sp. cf. *C. communis* d'Orbigny. " " "
Nodosaria sp. cf. *N. insecta* Schwager. Culebra formation.
Uvigerina sp. (?)
Orbulina sp.
Globigerina sp.
Truncatulina wuellerstorfi Schwager. Culebra formation also Recent.
Siphonina sp. cf. species from Oligocene of the United States.
Pulvinulina sp. cf. species from Oligocene of the United States.
Asterigerina sp. cf. species from Oligocene of the United States.
Amphistegina sp.
Ellipsoidina sp.

Madreporaria:

Obicella sp. cf. a species from the lower Miocene of Trinidad and Vieques Island.
Psammocora sp. cf. a species from the Miocene of Trinidad. Other species of this genus are known from the lower Miocene of Trinidad, Vieques Island, and the Dominican Republic.

Geologic correlation.—The basis for correlating this deposit is not definite, but the horizon seems to be very low Miocene.

Vieques Island

At Punta Salinas, east of Port Salinas and Salina del Sur, at the east end of the island, and along the south shore from opposite Esperanza to Enseñada de la Chiba, there is soft, light-colored, usually yellowish, bedded, fossiliferous limestone, which although slightly tilted and in places flexed, has been, in comparison with the older hard blue limestone, only slightly disturbed. Between Enseñada Sombe and Port Mosquito, between Port Mosquito and Port Ferro, and on the east side of Port Ferro, steep, northward-facing slopes mark the northern edges of the areas of its outcrop. The following are the paleontologic determinations for Vieques:

Station 8652. Vieques Island, north side, east end, the westernmost of the yellow marl and limestone bluffs at the east end of the island.

Foraminifera:

Gaudryina triangularis Cushman. Also Yumurí River, Cuba, U. S. G. S. 3461, and 6010, Culebra formation, Panama Canal Zone; Recent.
Verneuilina spinulosa Reuss. Also Yumurí River, Cuba, U. S. G. S. 3461; Recent.

Chrysalidina pulchella Cushman? Also U. S. G. S. Station, 6036 Gatun Formation, Panama Canal Zone.
Discorbis bertheloti (d'Orbigny). Also Choctawhatchee marl, one mile south of Red Bay, Fla.; Recent.
Truncatulina americana Cushman. Also Miocene of Coastal Plain, U. S.; upper part of Culebra formation, Panama Canal Zone; and Oligocene of Coastal Plain, U. S.
Truncatulina wuellerstorfi (Schwager) ? Miocene of Coastal Plain, U. S.; Oligocene of Panama Canal Zone; Recent.
Truncatulina lobatula (Walker and Jacob.) Also 3461, Yumurí River, Cuba; Cercado de Mao, Dominican Republic; Recent.
Pulvinulina menardii (d'Orbigny)? Also 6033-35-36, Gatun Formation, Panama Canal Zone; Recent.
Gypsina globulus (Reuss) var. *pilaris* H. B. Brady. Also Bowden, Jamaica; Anguilla?; Recent.
Nonionina scapha (Fichtel and Moll.) Also 6033, Gatun Formation, Panama Canal Zone; Recent.
Quinqueloculina seminulum (Linné). Also Gatun Formation and Culebra Formation, Panama Canal Zone; Recent.
Orbitolites duplex Carpenter? Also Anguilla, St Martin; Recent.

Only 2, 83 per cent, of the species above listed are not reported from the living foraminiferal faunas.

Madreporaria:
Stylophora sp.
Orbicella altissima (Duncan). Also Miocene of Trinidad.
Orbicella sp. Also Miocene of Trinidad.
Orbicella or *Solenastrea* sp.
Siderastrea siderea (Ellis and Solander). Range from lower Miocene to Recent.
Psammocora sp. Also Miocene of Trinidad.
Porites sp.

Mollusca:
Ostrea haitiensis Sowerby.
Teredo sp., like *Kuphus incrassatus* Gabb.

Geologic correlation.—The two species of *Orbicella*, and the species of *Psammocora* and *Ostrea haitiensis*, all indicate an old Miocene age, probably older than that of the Bowden marl of Jamaica. *Siderastrea siderea* is not known from deposits older than Miocene and persists today in Caribbean and Floridian waters.

Station 8654. Vieques Island, sea bluff at Cucuracha Light, south side of the island.

Foraminifera:
Gypsina globulus (Reuss). Also Recent.
Asterigina sp.
Orbiculina sp.

Madreporaria:
Solenastrea bournoni Milne Edwards and Haime. Also Recent.

Mollusca:

Turritella sp.
Ostrea sp., probably *O. haitiensis* Sowerby.
Pecten sp., close to *P. ventonensis* Cooke and *P. soror* Gabb but apparently different from both.
Spondylus sp.
"*Lucina*" sp.
Teredo sp., like *Kuphus incrassatus* Gabb.

Geologic correlation.—That the rocks from which the fossils obtained at Station 8654 are not older than Miocene is shown by the presence of *Solenastrea bournoni;* while the oysters and the *Pecten* indicate that they are as old as Miocene.

Eastern Porto Rico

On the north side of the road from Fajardo to San Juan, about 5 kilometers east of Rio Piedras, there is a low hill composed of argillaceous, yellowish limestone. The following fossils were collected here:

Station 8653. Porto Rico, 5 kilometers east of Rio Piedras, north side of road from San Juan to Fajardo. Collected by T. W. Vaughan.

Foraminifera:

[2] *Asterigina* sp.
[1] *Orbitolites* sp.
[1] *Orbiculina* sp.
[1] *Quinqueloculina* sp.

Madreporaria:

Pocillopora sp., apparently new species related to *P. crassoramosa* Duncan.
Siderastrea sp., apparently new species.
[1] *Porites* sp. or *Goniopœa* sp., of the growth form of *Goniopora clevei,* Vaughan.
[2] *Porites* sp. aff. *P. astreoides* Lamarck
Porites sp.

Bryozoa:

[1] *Holoporella albirostris* Smitt.

Mollusca:

[1] *Teredo* sp., like *Kuphus incrassatus* Gabb.

Geologic correlation.—Either uppermost Oligocene or very low Miocene. The forms whose names are preceded by "1" are known in deposits of both upper Oligocene and lower Miocene age; those preceded by "2" are not known at a horizon below Miocene.

Summary statement on deposits of Tertiary age.—In the foregoing remarks it has been stated that deposits of middle Oligocene (Rupelian) and probably upper Oligocene (Aquitanian) age occur in Saint Croix and that deposits of lower Miocene (Burdigalian) age occur probably in Saint Croix, certainly in Vieques, and probably on the north side of

Porto Rico east of San Juan. As I have given in the final part of Bulletin 103 of the United States National Museum a rather full account of the distribution of marine deposits of these ages, except for the Virgin Islands, Porto Rico, and the island of Haiti, I will not repeat what I published, except in so far as it bears on the problems under discussion.

From corals collected by R. T. Hill in western Porto Rico in 1898 I pointed out in notes published by Hill in 1899 that his Pepino formation is of the same age as the Antigua formation which is now classified as of middle Oligocene (Rupelian) age. In addition to this horizon Miss Maury has recently recognized upper Oligocene and lower Miocene in western Porto Rico. The geologic exploration made for the Military Government during April, May, and June, 1919, in the Dominican Republic has led to the recognition there of upper Eocene, middle Oligocene, upper Oligocene, and six Miocene horizons of which the lowest and the upper three are new—that is, at least seven definable new Tertiary horizons were recognized in the Dominican Republic. South of Santiago, near Baitoa, Condit and Cooke found the basal Miocene resting on the deformed, folded, and eroded surface of middle Oligocene deposits which carry the Antiguan foraminiferal and coral fauna. The specimens of *Lepidocyclina* are equaled in size only by those in Antigua where some are four inches in diameter. The Eocene formations of the Republic of Haiti have been briefly discussed by Woodring in two recent papers.[6] Later the significance of these determinations will be indicated.

Pleistocene deposits

Although I did not land on the Cordilleras reefs, I could see from the subchaser on which I travelled that they are composed of limestone. A specimen of soft limestone from Icacos Key, given me by Mr. Jorge Byrd-Arias, is a very fine-grained oolite. I suppose that this rock is of Pleistocene age from analogy with Florida and the Bahamas.

SUMMARY OF GEOLOGIC HISTORY

(1) The presence of shoal water deposits of Upper Cretaceous age, in Saint Croix and in the islands on the Virgin Bank from Saint John to Porto Rico and in Porto Rico shows that the major tectonic axis of this part of the West Indies antedates Upper Cretaceous time,

[6] Woodring, W. P., Middle Eocene foraminifera of the genus *Dictyoconus* from the Republic of Haiti: this Journal 12: 244–247. 1922; and An outline of the results of a geological reconnaissance of the Republic of Haiti: Ibid. 13: 117–120. 1923.

because there was an antecedent basement on which these deposits were laid down. I have suggested that these major trends may be even as old as late Paleozoic.

(2) During Upper Cretaceous time it is probable that most of, perhaps all of, the areas now occupied by land were under water; and that there was considerable volcanic activity is proved by the water-laid tuffs and lava flows which are interbedded with the shoal-water calcareous sediments.

(3) In early Tertiary, probably Eocene, time there was mountain making by folding which in places was so intense that the stratified rocks were left in an almost vertical position and both the sediments and the older igneous rocks were metamorphosed. There were also intrusions of diorite, dolerite, and quartz diorite, and probably the extrusion of some volcanic rocks. West of the Virgin Islands, there was during later Eocene time extensive submergence in the Dominican Republic, Haiti, and Cuba, as is attested by the Eocene formations now above sea-level in those areas.

(4) The episode of mountain making was followed in the Virgin Islands by one of prolonged subaerial erosion, and the production of the Virgin Bank apparently may in large part be assigned to this period of the history of the region. It seems that the axial islands on the Virgin Bank and the Central Sierras of Porto Rico, from its east to its west end, have continuously stood above the water since the close of Cretaceous deposition. In Saint Croix by middle Oligocene time erosion had proceeded far enough to reduce almost to base level the tightly, steeply folded strata of the mountains.

(5) In middle Oligocene time a large part of Saint Croix wes submerged and, with slight fluctuations, remained under water until sometime during the Miocene. Although both the northern and southern, but not the axial, parts of western Porto Rico were submerged in middle Oligocene, and probably in lower Oligocene time, the eastern end of Porto Rico and the axial islands of the Virgin Bank west of Anegada Island were not submerged. The age of the limestone on Anegada Island is not known. These facts mean that there was differential movement, the movement being greater toward the west than in the central part of the bank. In lower Miocene time the northern shore of Porto Rico east of San Juan was submerged as were also the southern shore and eastern end of Vieques Island—both the northern and the southern edges of the bank were submerged probably by marginal down flexing. Although there are corals in the exposed sediments of Oligocene and Miocene age, and corals were therefore constructional agents during those epochs, their work as compared with

that of other agents was of minor importance. If the work of these organisms in forming deposits concealed under water can be evaluated by their work in deposits exposed to view, the conclusion would be drawn that they played only a minor rôle in the formation of the Virgin Bank. There is as yet no evidence showing intense deformation during later Oligocene time in the Virgin Islands and Porto Rico such as is known to have taken place in the Dominican Republic.

(6) Subsequent to early Miocene time there has been uplift, greater along the axis of Porto Rico and the Virgin Bank than on the flanks, bringing Miocene and older Tertiary sediments, in places where they are present, above sea level. The Tertiary sediments are tilted and gently flexed but they have not been so much deformed as the Upper Cretaceous deposits. It is about this time that the land connections permitting migration of land animals from Anguilla to Porto Rico, Haiti, and Cuba seem to have existed. Saint Croix seems to have been connected with Anguilla, Saint Martin, and Saint Bartholomew.

(7) The period of high stand of land was followed by faulting, such as I have several times described recently; but, as pointed out by Woodring, the faulting was concomitant with folding. By these processess Anegada Passage between the Virgin Bank and Anguilla was produced and the islands assumed very nearly the outlines and arrangements of today.

(8) Subsequent to the episode of faulting there was emergence of the land, and terracing of the margins of the Virgin Bank, followed by submergence. In places in Porto Rico and along the Cordilleras reef, which extends eastward from the northeast corner of Porto Rico, there has been local emergence due to differential crustal movement.

(9) The living coral reefs on the Virgin Banks are growing on an extensive flat in a period of geologically Recent submergence. This flat is geologically an old feature. Its origin in large part at least may reasonably be attributed to the long period of erosion following early Tertiary mountain-making.

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SPECTROSCOPY—*Regularities in the arc spectrum of vanadium.*[1] W. F. MEGGERS, Bureau of Standards.

Kossel and Sommerfeld, in 1919, proposed the spectroscopic displacement law[2] (Verschiebungssatz) which states that the spark spectrum of any chemical element resembles in structure the arc spectrum of the element preceding it in the periodic system. This led to the alternation law[2] (Wechselsatz); that is, the even and odd structures of both arc and spark spectra alternate between adjacent columns of the periodic classification. Until recently, the validity of these laws could be tested only in the first three columns since scarcely any spectral regularities were known except for the relatively simple spectra of elements in these groups. The incomplete and inaccurate description of the more complex spectra has been responsible, in part, for the delay in finding significant regularities among them. In recent years many of these spectra have been more accurately measured in international Angstrom units, and the majority of them have had their wave-length tables extended into the red and infra-red regions, chiefly as the result of investigations by the Spec-

[1] Received July 16, 1923. Published by permission of the Director, Bureau of Standards.

[2] Sommerfeld, Atombau und Spektrallinien 3rd Ed; 456. 1922.

troscopy section of the Bureau of Standards.[3] With these more accurate and extensive data at hand this laboratory undertook to analyze the spectra of one or more elements in each of the higher columns of the periodic system, hoping thus to be able to test the proposed spectroscopic laws and to shed further light on the structure of the atom and on the nature of radiation. The same problem was independently attached by Catalán[4] and because of this coincidence the goal has been reached somewhat earlier than could otherwise have been expected.

Attention was first given to the elements with atomic numbers 19 to 26 which occupy the fourth row of the periodic system, Columns I to VIII. These elements are potassium, calcium, scandium, titanium, vanadium, chromium, manganese and iron. The arc spectra of the first two had been fairly completely arranged into series[5] for many years, but of the remainder only fragments of series were known for manganese. These latter were recently extended by Catalán[6] who also found regularities in the spark spectrum and indicated many complex groups of lines for which he coined the word "multiplet." According to Back[7] the Zeeman effect in these spectra indicates that they are in agreement with the law of alternations as outlined by Landé[8] in a paper on Termstructure and Zeeman effect of Multiplets. Regularities in the arc spectrum of chromium were discovered quite independently by Kiess[9] Gieseler,[10] and Catalán.[11] Similar investigations on the arc spectrum of molybdenum were made independently by Kiess[12] and by Catalán.[13] The results for these two elements indicate that the alternation law is valid for column VI. The first spectral regularities for any element in column VIII were found by Walters[14] in the arc spectrum of iron. Titanium, of column IV has been successfully analysed by Kiess.[15] I undertook a study of scandium and vanadium as representatives of the remaining columns III and V respectively. Wave-length data for the scandium[16] arc-

[3] Bur. Standards Scientific Papers, 312, 324, 329, 345, 372, 411, 421, 442, 466.
[4] Anales Soc. Espan. Fis. y Quim. 21: 84, 1923.
[5] Fowler, Series in Line Spectra, 1922.
[6] Phil. Trans. Roy. Soc. London A 223: 127. 1922.
[7] Zeit. f. Physik 15: 206. 1923.
[8] Zeit. f. Physik 15: 189. 1923.
[9] Science 56: 666. 1922.
[10] Ann. der Physik (IV) 69: 147. 1922.
[11] Anales Soc. Espan. Fis. y Quim. 21: 84. 1923.
[12] Bur. Standards Sci. Pap. No. 474.
[13] Anales Soc. Espan. Fis. y Quim. 21: 213. 1923.
[14] Journ. Wash. Acad. Sci. 13: 243. 1923.
[15] Journ. Wash. Acad. Sci. 13: 270. 1923.
[16] To be published in Bur. Standards Sci. Pap.

spectrum were first extended to the red and infra-red, and the analysis was practically complete when Catalán's[17] paper giving a partial explanation of both arc and spark spectra of this element appeared. My efforts were then concentrated on vanadium, and in this paper some examples of the regularities in the arc spectrum of this element are presented.

Wave-lengths of the spectral lines are taken from the measurements made by Ludwig,[18] (2400 A to 4646 A), Kiess and Meggers[19] (5500 A to 9400 A), and Exner and Haschek,[20] the latter being corrected to the international scale. Arabic and Roman numerals following each wave-length refer respectively to the intensity and temperature class of the line. King[21] made a valuable study of the variation with temperature of the electric furnace spectrum of vanadium in the region 3165 A to 6842 A. In this interval the arc intensities as estimated by King (loc. cit.) are used because he employed a larger scale (1 to 150) than the usual one (1 to 10) and made finer distinctions which are important in studying intensity rules governing lines of a multiplet. Under each wave-length is given the "frequency" or number of waves per cm. corrected to vacuum by the tables of Meggers and Peters.[22] The wave number differences or poly-fold level separations occurring in each group are given in italics between the connected pairs of lines.

Tables of the arc spectrum of vanadium contain about 2000 lines and about 15 per cent of these have now been assigned to multiplets. A few of the examples given below will require special study to settle doubtful points. For instance the lines 3184.00, 4384.73 and 4408.52 may be double. The first of these appears in multiplet 14 and from King's estimate of 60 for its intensity I have assumed it to consist of two lines of practically the same wave length and intensity. By so doing, the structure of the multiplet is completed and the distribution of intensity among its lines becomes normal. The same applies to multiplet 16 containing the line 4408.52 A to which King assigned the intensity 90. This work is still in progress, and a more detailed presentation and discussion of the results will appear later in the Scientific Papers of the Bureau of Standards. The evidence here given shows that vanadium falls into the general scheme as

[17] Anales Soc. Espan. Fis. y Quim. 20: 606. 1922.
[18] Zeit. f. Wiss. Phot. 16: 157. 1917.
[19] B. S. Sci. Papers 16: 51. 1920.
[20] Kayser, Handbuch der Spektroscopie VI.
[21] Astroph. Journ. 41: 86. 1915.
[22] Bull. Bur. Standards 14: 697. 1918.

predicted and now for the first time it can be stated positively that the alternation law of Kossel and Sommerfeld is verified for arc spectra across the entire table of chemical elements.

In order to test the displacement law, further study of spark spectra is required. Of the chemical elements mentioned above, regularities in spark spectra have been published only for potassium,[23] calcium,[5] scandium[17] and manganese.[6] A program of investigations of spark spectra has been initiated at the Bureau of Standards in order that the structures of these spectra may become known, especially for those elements the plan of whose arc spectra has now been revealed.

TABLE I—MULTIPLETS IN THE ARC SPECTRUM OF VANADIUM

Multiplet 1.

4594.10	(60, I)	4577.18	(40, I)				
21760.96	*80.47*	21841.43					
		137.40					
		4606.15	(15, I)	4580.40	(40, I)		
		21704.03	*122.01*	21826.04			
		186.07		*186.08*			
		4645.98	(1, IIIA)	4619.79	(25, I)	4586.37	(50, I)
		21517.96	*122.00*	21639.96	*157.69*	21797.65	
						229.54	
						4635.18	(15, I)
						21568.11	

Multiplet 2.

4851.51	(40, I)	4832.43	(30, I)	4799.70	(5, IIA)		
20606.41	*81.34*	20687.75	*104.68*	20828.43			
		137.33		*137.31*			
		4864.73	(40, I)	4831.64	(35, I)	4784.50	(5, IIA)
		20550.42	*140.70*	20691.12	*203.90*	20895.02	
				186.00		*185.90*	
				4875.47	(40, I)	4827.45	(30, I)
				20505.12	*204.00*	20709.12	
						229.53	
						4881.55	(50, I)
						20479.59	

[23] Nissen. Astroph. Journ. 57: 185. 1923.

Multiplet 3.

8198.85	(3)	8144.52	(3)				
12193.49	*81.33*	12274.82					
63.25		*63.26*					
8241.60	(4)	8186.71	(3)	8093.47	(2)		
12130.24	*81.22*	12211.56	*140.70*	12352.26			
		102.33		*102.31*			
		8255.90	(4)	8161.03	(4)	8027.34	(2)
		12109.23	*140.72*	12249.95	*204.07*	12454.02	
				137.18		*137.24*	
				8253.48	(4)	8116.78	(5)
				12112.77	*204.01*	12316.78	

Multiplet 4.

4330.03	(30, I)	4307.19	(12, I)				
23088.04	*122.46*	23210.50					
137.40		*137.37*					
4355.96	(10, I)	4332.83	(30, I)	4306.22	(15, I)		
22950.64	*122.49*	23073.13	*142.57*	23215.70			
		186.01		*186.07*			
		4368.05	(10, I)	4341.02	(40, I)	4309.80	(20, I)
		22887.12	*142.51*	23029.63	*166.79*	23196.42	
				229.59		*229.61*	
				*4384.73	(125, II)	4352.89	(50, I)
				22800.04	*166.77*	22966.81	

Multiplet 5.

6812.42	(2, IIIA)						
14675.02							
63.21							
6841.90	(1, IIIA)	6785.02	(3, IIIA)				
14611.81	*122.48*	14734.29					
		102.32					
		6832.47	(1, IIIA)	6766.53	(4, IIIA)		
		14631.97	*142.59*	14774.56			
				137.13			
				6829.92	(1, IIIA)	6753.03	(5, IIIA)
				14637.43	*166.66*	14804.09	

Multiplet 6.

3855.37	(30, I)	3844.44	(20, I)				
25930.53	*73.70*	26004.23					
137.43		*137.38*					
3875.91	(20, I)	3864.86	(35, I)	3847.33	(20, I)		
25793.12	*73.73*	25866.85	*117.84*	25984.69			
		186.08		*186.06*			
		3892.86	(25, I)	3875.08	(35, I)	3841.89	(5, IA)
		25680.77	*117.86*	25798.63	*222.87*	26021.50	
				229.68		*229.55*	
				3909.89	(20, I)	3876.08	(20, I)
				25568.95	*223.00*	25791.95	

Multiplet 7.

5706.98	(30, I)						
17517.55							
63.26							
5727.67	(20, II)	5703.59	(40, I)				
17454.29	*73.67*	17527.96					
102.34		*102.17*					
5761.45	(2, IIIA)	5737.03	(25, II)	5698.49	(60, I)		
17351.95	*73.84*	17425.79	*117.85*	17543.64			
		137.28		*137.29*			
		5782.59	(2, IIIA)	5743.44	(18, II)	5670.83	(30, I)
		17288.51	*117.84*	17406.35	*222.87*	17629.22	

Multiplet 8.

3781.40	(1, II)	3771.66	(1, IA)				
26437.76	*68.25*	26506.01					
		137.50					
		3791.33	(2, IA)	3777.17	(2, IA)		
		26368.51	*98.88*	26467.37			
				186.00			
				3803.90	(6, IA)	3784.68	(2, IA)
				26281.37	*133.50*	26414.87	
						229.49	
						3817.85	(8, IA)
						26185.38	

Multiplet 9.

4109.78	(50, I)						
24325.36							
40.88							
4116.70	(4, IA)	4105.17	(60, I)				
24284.48	*68.22*	24352.70					
66.93		*66.93*					
4128.08	(60, I)	4116.48	(50, I)	4099.80	(60, I)		
24217.55	*68.22*	24285.77	*98.83*	24384.60			
		91.32		*91.15*			
		4132.02	(60, I)	4115.18	(60, I)	4092.69	(50, I)
		24194.45	*99.00*	24293.45	*133.46*	24426.91	
				113.52		*113.44*	
				4134.50	(60, I)	4111.79	(100, I)
				24179.93	*133.54*	24313.47	

Multiplet 10.

3835.56	(4, II)	3826.77	(6, II)		
26064.43	*59.88*	26124.31			
63.21		*63.23*			
3844.89	(4, II)	3836.06	(5, I)	3823.98	(5, II)
26001.22	*59.86*	26061.08	*82.32*	26143.40	
		102.30		*102.31*	
		3851.17	(5, I)	3839.00	(10, I)
		25958.78	*82.31*	26041.09	
				137.22	
				3859.34	(6, II)
				25903.87	

Multiplet 11.

2899.60	(8)	2894.58	(5)	2887.71	(1)		
34477.40	*59.79*	34537.19	*82.24*	34619.43			
		137.27		*137.32*			
		2906.98	(8)	2899.21	(8)	2888.52	(1)
		34399.92	*82.19*	34482.11	*127.53*	34609.64	
				185.90		*185.93*	
				2914.92	(10)	2904.13	(8)
				34296.21	*127.50*	34423.71	
						229.60	
						2923.63	(10)
						34194.11	

Multiplet 12.

4090.59	(25, I)						
24439.50							
166.52							
4118.65	(8, III)	4095.48	(25, II)				
24272.98	*137.29*	24410.27					
142.12		*142.09*					
4142.91	(2, III)	4119.46	(8, III)	4102.16	(20, II)		
24130.86	*137.32*	24268.18	*102.35*	24370.53			
		78.88		*78.88*			
		4132.90	(?)	4115.48	(2, III)	4104.78	(15, III)
		24189.30	*102.35*	24291.65	*63.35*	24355.00	

Multiplet 13.

3050.88	(3, R)	3043.55	(3, R)				
32767.90	*78.90*	32846.80					
137.33		*137.38*					
3063.72	(3)	3056.34	(3, R)	3043.12	(3, R)		
32630.57	*78.85*	32709.42	*142.02*	32851.44			
		186.07		*186.04*			
		3073.82	(3, R)	3060.46	(3, R)	3044.94	(4, R)
		32523.35	*142.05*	32665.40	*166.47*	32831.87	
				228.48		*229.49*	
				?3082.02	(4)	3066.37	(3, R)
				32436.92	*165.46*	32602.38	

Multiplet 14.

†3184.00	(25r, II)						
31398.06							
137.63							
3198.01	(20, II)	†3183.42	(30r, II)				
31260.43	*143.35*	31403.78					
185.61		*186.02*					
3217.11	(10, II)	3202.38	(25, II)	†3184.00	(35R, II)		
31074.82	*142.94*	31217.76	*180.30*	31398.06			
		229.56		*229.27*			
		3226.11	(4, II)	3207.42	(20, II)	†3185.40	(40R, II)
		30988.20	*180.59*	31168.79	*215.38*	31384.17	

Multiplet 15.

		4436.14	(15, I)								
		22535.82									
		40.95									
4452.02	(20, III)	4444.22	(20, I)	4428.52	(15, I)						
22455.42	*39.45*	22494.87	*79.72*	22574.59							
		66.96		*66.92*							
		4457.48	(15, I)	4441.69	(25, I)	4419.94	(12, I)				
		22427.91	*79.76*	22507.67	*110.71*	22618.38					
				91.25		*91.20*					
				4459.77	(30, I)	4437.84	(20, I)	4412.14	(12, I)		
				22416.43	*110.75*	22527.18	*131.21*	22658.39			
						113.43					
						4400.30	(50, I)				
						22413.75					

Multiplet 16.

4408.52	(45, I)	4400.59	(60, II)								
22677.01	*40.86*	22717.87									
40.88		*40.86*									
4416.48	(20, I)	4408.52	(45, I)	4395.24	(80, II)						
22636.13	*40.88*	22677.01	*68.50*	22745.51							
		67.01		*66.90*							
		4421.58	(20, I)	4408.21	(70, I)	4389.99	(100, II)				
		22610.00	*68.61*	22678.61	*94.13*	22772.74					
				91.22		*91.29*					
				4426.01	(20, I)	4407.66	(70, I)	4384.73	(125r, II)		
				22587.39	*94.06*	22681.45	*118.61*	22800.04			
						113.39		*113.41*			
						4429.80	(15, I)	4406.65	(80, I)	4379.24	(150r, II)
						22568.06	*118.57*	22686.63	*141.98*	22828.61	

* *Cf.* Multiplet 16. † Raies ultimes.

PHYSICS—*A comparison of the heating-curve and quenching methods of melting-point determinations.*[1] GEORGE W. MOREY. Geophysical Laboratory, Carnegie Institution of Washington.

The temperature of equilibrium between liquid and solid phases of a pure substance, or of the beginning or end of melting in a mixture, is a datum point frequently determined, and any information bearing on its determination is of interest to the investigator. The following experiments were carried out to compare the heating-curve method, which is the method followed almost exclusively in the study of metals and of salts which crystallize readily, with the quenching method, used chiefly in the study of substances which are difficult to crystallize, such as the silicate minerals. In the latter method, a tiny charge, of a few milligrams, is wrapped in thin platinum foil, and held at a definite temperature until equilibrium is reached. The charge is then suddenly cooled, sometimes by dropping into mercury, sometimes by merely lifting out of the furnace, and examined under the microscope. If the heating has been above the melting-point, the examination will show only glass; if below the melting-point, only crystals; and repetition at the same temperature for varying times will show how long it is necessary to wait for equilibrium. This method is the choice of all familiar with it, whenever it can be applied, because of the unequivocal nature of the evidence it supplies; it is, however, only applicable to substances which are sluggish crystallizers, such as the silicates, borates, and phosphates, and is not applicable to most salts.

In the case of the silicate minerals, cooling-curves are rarely of value, because of the great tendency toward undercooling, and the use of heating-curves is made difficult by the same sluggishness. In metals and in easily crystallizable salts such as sodium sulfate the heating-curve shows a sharp break both at the beginning and end of melting, and usually an actually flat portion between. In the case of the silicate minerals the heating-curve is rarely sharply broken, and often is oblique. The causes of the obliquity have been fully discussed by White;[2] but the exact location of the melting-point remains a matter of some difficulty. It therefore seemed desirable to compare the two methods on a substance which gives a fair heating-curve, and also enables the melting-point to be located exactly by means of quenches. Sodium metasilicate is such a substance, and accordingly

[1] Received July 11, 1923.

[2] W. P. White, Am. Journ. Sci. 28: 453-73. 1909.

a series of quenches and of heating-curves were run on a sample of sodium metasilicate containing a slight excess of SiO_2, analysis giving a ratio of SiO_2 to Na_2O of 1.007. Heating curves were made with a

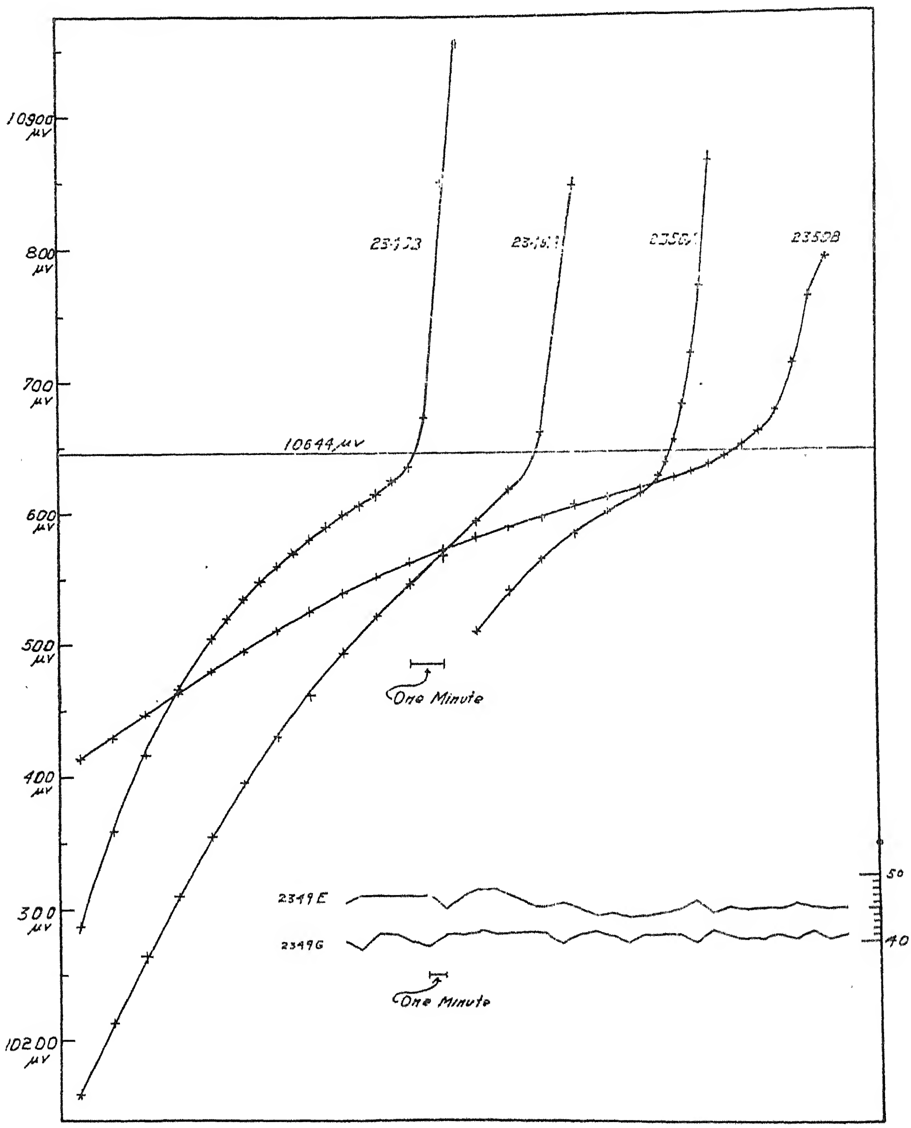

Fig. 1. Curves obtained on heating a charge of sodium metasilicate at various rates

bare platinum-platinrhodium thermocouple. The charge was contained in a thimble crucible of platinum, 1 cm. in diameter and 2 cm. deep,

and the furnace used had a zone of 4 cm. in which the temperature was uniform to one degree.

In the quenching experiments the charge was placed within 1 mm of the bare thermocouple junction, and the whole carefully centered in the furnace. The furnace was kept at a constant temperature by a Roberts type thermoregulator,[3] and readings were made every minute. The two curves 2349 E and 2349 G in Fig. 1 give minute by minute readings for two of these experiments for 30 minutes; the maximum e.m.f. on 2349 G is 10642, the minimum 10640, with the exception of drops to 10639.0 and 10639.5 at the end of the first and fifth minutes, respectively.

The results of the quenching experiments are given in Table 1.

TABLE 1—Results of Quenching Experiments

EXPERIMENT NO.	TEMP. IN MICROVOLTS	CONDITION
2449C	10632	Crystalline
2449G	10641	"
2449F	10650	Glass
2449E	10645	"
2449D	10643	Both crystals and glass

The melting point of this sodium metasilicate can with certainty be placed at 10644 microvolts with this particular element; the actual temperatures do not concern us here. 1 microvolt is equivalent at this temperature to about 0.09°C.

Two heating curves were run before the quenches, 2349 A and 2349 B, and two after, 2350 A and 2350 B. Readings were in some cases taken every 30 seconds, in others, every minute. The experimental results are shown by the curves of Fig. 1, on which the determined points are represented by crosses; the ordinate for the melting-point as determined by quenches, 10644, has also been drawn. The curves drawn thru the observed points are of course wholly empirical hence the exact location of the point of inflection is impossible.

Examination of the data shows that in each case the ordinate for 10644 cuts the curve in the region of steeply ascending slope. In 2349 A, the increase of e.m.f. for the time interval which includes the ordinate 10644 is 44 microvolts, while in the preceding interval the e.m.f. increased 23 microvolts; similarly, in 2349B, the increments are 38 and 11; in 2350A, 17 and 9; in 2350B, 10 and 8. The precise location

[3] H. S. Roberts. This Journal 11: 401. 1921.

of the melting-point from these curves is, however, arbitrary, and comparison with the quenching experiments shows that in most cases the tendency is to put the melting-point too low. This is the effect to be expected from the discussion given by White of the factors affecting the melting-point determination. For example, in the discussion of the effect of variable rate of heat supply,[4] he says: "The result is to hurry up the latter end of the melting, apparently increasing its obliquity." Again, in the discussion of the heat distribution within the charge,[5] ". . . the resulting distortion . . . is a rapidly accelerated increase, changing the form of the curve in that region. In large crucibles it often masks the break at the end of the melting, substituting for it a premature break a degree or two lower down, due to the rapid increase in heat supply before the melted layer has touched the thermoelement at all."

This latter consideration appears to me to be of the greatest importance in silicate melts; together with a consideration of the data given above, it justifies the conclusion that whenever possible the results of melting-point data should be checked by the more accurate, as well as more convenient, quenching method; where the quenching method is not applicable, confirmation by some other static method, such as the change in volume, is desirable.

SUMMARY

The heating-curve method, which is the method followed almost exclusively in the study of metals and of salts which crystallize readily, is compared with the quenching method, used chiefly in the study of substances which are difficult to crystallize, such as most silicates. It is well recognized both in theory and practise that the melting-point of a substance of the latter class is more accurately determinable by the quenching method. Taking the melting-point determination by this method as the standard, it is shown that the true melting-point lies on the more rapidly rising end portion of the heating curve. As usually interpreted, therefore, the heating-curve method tends to give a melting-point which is too low. The difference in the present case (sodium metasilicate) is of the order of magnitude of 2° or less at about 1100°.

[4] Op. cit., p. 461.
[5] Op. cit., p. 464.

CHEMISTRY—*The residue from silica in rock-analysis.*[1] M. AUROUSSEAU. (Communicated by H. S. WASHINGTON.)

The usual procedure in rock-analysis, when dealing with the "main portion" is to decompose about one gram of the rock powder by fusion with five times its weight of sodium carbonate. The cake is brought into chloride solution, the solution evaporated to dryness and the silica separated and washed by cold filtration. The silica is then ignited in a weighed platinum crucible, weighed, driven off by hydrofluoric acid, and the crucible and residue which it invariably contains are again weighed after ignition. Hillebrand and Washington have both commented on the amount and nature of this residue, and Bloor has investigated it in connection with the analysis of clays—a somewhat different process from the analysis of rocks.[2]

Both Hillebrand and Washington agree that the residue is of constant occurrence, that it differs in nature and in quantity with different kinds of rocks, and that it contains chiefly oxides of titanium, iron, and phosphorus. The former states that it is quantitatively precipitable with ammonia, and that it should contain little if any lime or magnesia if the rock has been properly decomposed. This is not in agreement with Bloor's results. His residues were complex in composition, and many of them contained lime and magnesia in notable quantity. No statement of the quantitative composition of the residues obtained in *rock* analysis has ever been published. Hillebrand states that he has tested residues, after the appearance of Bloor's paper, and is not able to substantiate Bloor's results. In my experience, the behavior of similar rocks is very irregular, even under conditions of work subject to little variation. For example, in analyzing a series of basalts from Etna, the residues obtained were unlike in quantity and appearance. Taking all precautions to ensure complete decomposition, the residue sometimes indicates that this was not attained.

While analyzing the new material (a silicic andesite) which rose in the crater of Lassen Peak, Cal., during its period of activity since 1914, opportunity was afforded to collect and analyze the residue from the silica of an andesite. One incomplete and two complete

[1] Received July 12, 1923.

[2] Hillebrand, W. F. The analysis of silicate and carbonate rocks. U. S. G. S., Bull. 700, 1919, pp. 104–105, and 119 (first footnote).

Washington, H. S. The chemical analysis of rocks, 3rd. Ed., New York, 1919, p. 146.

Bloor, W. R. Journ Am. Chem. Soc., 29, 1907, p. 1603.

analyses of different modifications of the rock were executed. They indicated only the slightest variation in composition, any one of them being quite representative of the rock. These results will doubtless be published elsewhere, and therefore the average of the three will be used here. In addition, a number of determinations of ferrous and total iron were made on the same material, the latter providing the residues examined.

Three portions, amounting to 3.0008 grams, of rock powder provided 0.0165 gram of residue. This was obtained by three separate fusions, carried out under identical conditions. Nevertheless, the third fusion, judging from the appearance of the residue, was not as effective as the others. After expelling the hydrofluoric and sulphuric acids, the residues were ignited for an hour in the electric furnace at a temperature of 850°C., in an oxidizing atmosphere. They were collected, after weighing, by ordinary sodium carbonate fusion, and were analyzed in the usual way, except for the deviations required for MnO and P_2O_5. The composition of the residue by weight was found to be as follows:

	grams
Al_2O_3	0.0021
Fe_2O_3	0.0041
CaO	0.0003
MgO	0.0026
TiO_2	0.0049
P_2O_5	0.0003
MnO	none
SO_3	0.0013
Undetermined	0.0009
Total	0.0165

The residue thus consists principally of the oxides of titanium, iron, magnesium, and aluminium. The quantity of MgO and the presence of SO_3 are somewhat surprising.

The interest and significance of the composition of the residue, for the analyst, lies in its relation to the composition of the rock. On a percentage basis, the constituents determined amount to 0.52 per cent of the rock (column 2, table 1). If the amount of each oxide in the residue be compared with the amount of the corresponding oxide in the rock, it is evident from column 3 of table 1 that TiO_2, MgO, and Fe_2O_3 (the relation is to total iron) have here shown the greatest tendency to remain behind in the residue. It is to be noted that only a negligible proportion of the P_2O_5 remained behind, and relatively little alumina. The subjoined table expresses the results clearly.

The complexity of the composition of the residue raises the question of its recovery. Fortunately this offers no difficulty and takes place during the subsequent course of analysis. The precipitate thrown down by ammonia in the filtrate from silica is ignited and weighed in the same crucible as the residue, when fusion with potassium pyrosulphate renders all the iron, alumina, titanic oxide, and phosphorus available for determination. Lime and magnesia, and possibly a little baria are not recovered, unless great accuracy is required. The amount of lime or baria the residue is likely to contain is negligible,

TABLE 1

	1	2	3
SiO_2	63.54		
Al_2O_3	16.93	0.07	0.4
Fe_2O_3	1.69	0.14	3.8
FeO	2.67		
MgO	2.77	0.09	3.3
CaO	5.07	0.01	0.02
Na_2O	4.08		
K_2O	2.18		
H_2O+	0.22		
H_2O-	0.04		
TiO_2	0.51	0.16	31.4
P_2O_5	0.14	0.01	0.7
SO_3		0.04	
S	0.02		
MnO	0.07		
BaO	0.07		
Sum	100.00	0.52	

1. Andesite. The Crater, Lassen Peak, California. The new lava of 1915. Average of one incomplete and two complete analyses. M. Aurousseau, analyst.
2. Oxides of the residue from silica, expressed as percentages of the rock.
3. Oxides of the residue expressed as percentages of the corresponding oxides of the rock.

and in a rock of the kind studied here the small amount of magnesia has but a slight effect on the final result, and its recovery is unimportant for any but the most exacting work.

The examination of the residue from silica in rock analysis is troublesome and inconvenient. The amount is small, and must be collected specially, if required for study. It is none the less highly desirable that residues from a wide range of rock composition (say from granite, diorite, basalt, nephelite syenite, and peridotite) be examined systematically, in order that some general conclusion might be drawn concerning the nature and behavior of the residue.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

886TH MEETING

The 886th meeting was held in the Cosmos Club Auditorium on Saturday, May 5, 1923. It was called to order at 8:15 p.m. by President WHITE with 35 persons in attendance.

The first paper, *Free-air pressure maps and their accuracy,* was presented by Mr. C. LEROY MEISINGER. The paper was illustrated by lantern slides and was discussed by Messrs. WHITE, LITTLEHALES, TUCKERMAN, HAWKESWORTH, HUMPHREYS, PAWLING, and GREGG.

Author's abstract: The variations of barometric pressure from day to day are of fundamental importance to the weather forecaster; but before the barometric readings can be compared, they must be reduced to some common level. At present, sea-level is the only reduction level in use, and for stations of no great elevation above this level the barometric indications correspond closely with surface weather conditions. But in high elevations the sea-level reductions are less satisfactory. The physical advantage of reduction upward to a free-air level is that horizontal barometric gradients correspond closely to the air movement at the same level. Moreover, the mean temperature of the air column (an important term in the hypsometric equation) is a real quantity in contrast with its fictitious nature when the reduction is downward.

The difficulties of securing current observations of the average temperature of the air column at a sufficiently large number of stations and of reducing them in time to be of current usefulness to the forecaster, necessitate the use of some regularly-observed surface weather element as an index to this quantity.

It was found upon analyzing a large body of aerological data that the difference between the mean temperature of the air column and the surface temperature varied markedly with surface wind direction and the season. A classification of these data in this manner enabled one to ascertain the geographical distribution and further to interpolate for non-aerological stations in the construction of tables for barometric reductions.

During the three months, December 1922 to February 1923, inclusive, daily post-card reports of 8 a.m. (75th meridian time) pressure at 1 and 2 kilometers (3281 and 6562 feet) above sea-level were made by 29 stations within the area embraced by the six aerological stations of the Weather Bureau. A statistical investigation of the accuracy of the reductions was made from two classes of data:

(1) Computed free-air pressures compared with pressures measured by kites at the aerological stations showed that 73% of the computations agreed within 0.05 inch. (Isobars on the daily weather map are drawn for intervals of 0.10 inch.)

(2) Wind directions in the free-air estimated upon the basis of the gradient wind relations, were compared with wind directions actually observed by means of pilot balloons, and it was found that the estimated wind was correct in 63% of the cases and the direction-error did not exceed 90° in 89% of the cases. It was discovered further that the average wind velocity for the various classes of error decreased markedly with increase of error, thus indicating that large errors of estimation were associated with very light winds and were, therefore, of little practical significance.

One of the outstanding uses of these charts is in connection with the supplying of free-air information to aviators at times when, through interference by large areas of clouds, pilot balloon observations are not possible. The practical utility of the charts for forecasting general weather must be determined after subjecting them to continuous comparison and study by experienced forecasters. The experience of the Japanese, however, with similar maps constructed somewhat differently has indicated that there are advantages for general forecasting. The fact that the degree of reliability of these maps is high, as indicated by the study of their accuracy, shows that, in any event, they afford a basis for studies relating to the physical processes within the lowest 2 kilometers of the atmosphere.

The second paper, *Air Navigation,* was presented by Mr. J. P. AULT. The paper was illustrated with lantern slides, and was discussed by Messrs. HEYL, LITTLEHALES, and HUMPHREYS.

Author's abstract: The method which has been used for the most part up to the present time in air navigation has been by dead reckoning. For cross-country flying and short flights over the water, a good compass and a good map are the two most important instruments required.

For long-distance flying, however, the aviator should be able to locate his position by some other means as, for example, by astronomical observations or by directional radio bearings, when he is unable to see objects on the ground during night flights or while flying above clouds or fog, or ocean.

The present paper described work which was done during the latter months of 1918 at Langley Field in the attempt to develop methods and instruments for navigating airplanes by astronomical observations. The problem is essentially the same as at sea to determine the position of a ship. Various experiments were made using the natural horizon, either land, sea, cloud, or haze, but these horizons will not always be available for the aviator. Some form of artificial horizon must be provided. Observations with a preliminary pendulum-type horizon gave results where the probable error of a single observation of the altitude of some celestial body amounted to $\pm 12'$ on the average.

Various methods of computing the results were tried, and special instruments for plotting the resulting position-line were developed.

A sextant with some form of artificial-level attachment, either pendulum or bubble, was found to be superior to the preliminary pendulum-type artificial horizon.

It became apparent that, when only one celestial body is available for observation, it would be necessary also to measure the azimuth of this body in addition to the altitude. Experiments along this line gave surprisingly good results. Azimuths of the sun could be determined with a probable error of ± 0.3 for means of 10 observations. Thus with some of the methods of reduction which are available, it will not be necessary for the aviator to know his dead-reckoned position very accurately if he is able to measure both the azimuth and the altitude of the celestial body.

Owing to the difficulties of navigation by astronomical methods and to the fact that frequently no celestial body can be seen on account of clouds or other conditions, the third method of navigation by some directional radio device seems to be the most promising as a solution of the problem. This method is as yet in the experimental stage.

887TH MEETING

The 887th meeting was held at the Cosmos Club Auditorium on Saturday, May 19, 1923. It was called to order at 8:15 p.m. by President WHITE with 60 persons in attendance.

President White commended the outgoing Program Committee for their splendid work during the year and announced the appointment of the new Program Committee for 1923–1924 as follows: Messrs. HEYL (Chairman), GISH, and MEISINGER.

A paper entitled *The Alchemist* was presented by Dr. PAUL D. FOOTE. It was illustrated with lantern slides and was discussed by Messrs. HAWKESWORTH, BRIGGS, RUARK, TUCKERMAN, WHITE, HUMPHREYS, and WILLIAMSON.

Author's abstract: A historical summary of the early alchemical literature was briefly presented. The elaborate experiments of these pseudo-investigators contributed somewhat to the progress of chemistry, but no transmutations of the elements were effected. Alchemy as a sound physical hypothesis had its origin within the past twenty years, and its possibility became evident with the modern development of our knowledge of atomic structure.

An atom consists of a planetary system of electrons revolving about a positively charged nucleus or sun. The nucleus or sun itself is a complicated structure, probably of a planetary nature, consisting of a group of closely bound hydrogen nuclei, helium nuclei, and electrons. The sun in a gold atom, for example, contains 49 helium suns, one extra hydrogen sun, and 20 electrons, all packed in the space of 30 billionth billionth billionth billionths of a cubic centimeter. Alchemy is concerned with the disintegration of these minute nuclear suns.

We have about 40 different radioactive species which are produced spontaneously and which represent transmutations of the elements in the strictly alchemical sense. Many radioactive elements give off helium. Some of the light elements may be transmuted into still lighter elements and hydrogen—the recent experiments of Rutherford in which the disintegration is produced by bombardment with alpha particles. Rutherford has stated that very likely every element may be transmuted as soon as the scientist is able to utilize an electric field of 10 million volts.

It seems probable that transmutation of baser metals into gold, platinum, and other rare metals may be effected on a small scale by several methods which were outlined and which were analogous to spontaneous radioactive disintegration or to the artificial disintegration by the Rutherford method. Such alchemical transformations on a large scale of production is, however, a problem for the distant future. It was pointed out that when that time comes, the problem of transmutation for the object of producing rare metals will shrink to insignificance compared to the greater interests which will develop simultaneously. For by whatever means quantity production is effected, the same methods can be employed in the creation of energy by the annihilation of mass. Thus if the hydrogen in two teaspoonsful of water were converted into helium, an amount of energy is liberated equivalent to $20,000 worth of electrical power at the current rates.

J. P. AULT, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The twenty-fourth biennial edition of the Directory of the Washington Academy of Sciences has just been issued. This contains the names and and addresses of members of the ACADEMY and of each of the 16 affiliated societies. A list of the scientific and technical societies of Washington which are not affiliated with the ACADEMY, and of national societies having headquarters or offices in Washington, is also included.

The following persons have become members of the ACADEMY since the last report in the Journal (August 19, 1922, p. 341). Except when otherwise noted the address is Washington, D. C.

C. W. LARSON, M. G. LLOYD, A. P. HITCHENS, W. L. CHENEY, E. W. BRANDES, F. H. SMYTH, F. W. SMITHER, G. E. F. LUNDELL, F. LA FLESCHE, V. BIRCKNER, L. L. STEELE, E. R. WEIDLEIN, University of Pittsburgh, Pittsburgh, Pa., W. S. FRANKLIN, Massachusetts Institute of Technology, Cambridge, Mass., A. T. PIENKOWSKY, H. S. ROBERTS, R. W. BALCOM, H. B. BROOKS, E. C. ECKHARDT, A. C. HUNTER, WILSON POPENOE, A. O. TOOL, E. A. GOLDMAN, E. R. WEAVER, EDWARD WICHERS, P. H. BATES, R. K. BEATTIE, R. F. JACKSON, J. B. S. NORTON, College Park, Md., W. F. STUTZ, J. M. SHERMAN, F. B. LAFORGE, W. A. SLATER, Urbana, Ill., A. G. BÖVING, R. H. DALGLEISH (reinstated), W. M. CORSE, E. P. KILLIP, C. G. PETERS, L. H. REICHELDERFER, H. SHAPLEY, Harvard Observatory, Cambridge, Mass., G. STEINER, O. P. HOOD, A. R. CHEYNEY, and W. P. WHITE.

Dr. RAUL GAUTIER, Director of the Observatory and Professor in the University of Geneva, Switzerland, was recently elected to honorary membership in the Washington Academy of Sciences in recognition of his prominence in geodesy and his intimate connection with scientific work in Washington.

The experimental research laboratory of the Navy Department, authorized by act of Congress in August, 1916, was formally placed in commission on July 2, 1923. The subjects studied at the laboratory will include: Gun erosion, torpedo motive power, the gyroscope, submarine guns, protection against submarine, torpedo and mine attack, improvement in submarine attachments, improvement and development in submarine engines, storage batteries and propulsion, aeroplanes and aircraft, improvement in radio installations, and other necessary work of the Government service. The laboratory is situated at Bellevue, D. C.

Dr. GEORGE N. ACKER died in Washington on July 22, 1923, in his seventy-first year. He was born in Washington, D. C., October 5, 1852. Dr. Acker was educated at Pennsylvania College, Columbian University (now George Washington University) and the University of Berlin. He held various positions on the medical staff of George Washington University from 1880 until his death. He was a member of the ACADEMY, Anthropological Society of Washington, and the Medical Society of the District of Columbia as well as many other medical societies.

The office of chief of the Bureau of Chemistry, which has been vacant since the resignation of Dr. C. L. ALSBERG in July, 1921, has been filled by

the appointment of Dr. C. A. BROWNE. Dr. Browne has for the past sixteen years been head of the New York Sugar Trade Laboratory and previously was chief of the sugar laboratory at the Bureau of Chemistry.

Non-political interests view with dismay the action of Dr. Hubert Work, Secretary of the Interior, in dismissing Mr. A. P. DAVIS and appointing in his place as director of the Reclamation Service former Gov. Davis of Idaho. Protests have been filed at the Interior Department by engineering and water-power organizations.

Dr. D. R. HARPER, physicist, U. S. Bureau of Standards, Washington, D. C., has been detailed to New York for service as liaison officer between the Bureau of Standards and the American Engineering Standards Committee in the Engineering Societies Building, New York City, succeeding Dr. A. S. MCALLISTER of the Bureau of Standards, recalled from New York to Washington. Dr. McAllister takes charge of part of Secretary Hoover's special work in relation to commodity standards and specifications, inaugurated recently under the Bureau of Standards.

Mr. W. E. MYER of the Smithsonian Institution has returned from Tennessee where for the past two and a half months he has been excavating the Great Mound Group in Cheatham county. He found traces of an important ancient town covering about 500 acres in two adjoining bends of Harpeth river. Many earth-lodge sites were excavated which yielded a considerable amount of information as to the life of the former inhabitants.

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GEOPHYSICS.—*Comagmatic regions and the Wegener hypothesis.*[1]

Henry S. Washington, Geophysical Laboratory.

In the many discussions of Wegener's hypothesis of sliding continents one factor in the problem and a possible test of the correctness of his ideas seems to have been somewhat neglected. This is the matching of materials at the edges of the pieces in the jig-saw puzzle—whether they would fit well together, not in outline but in the character of the crustal material, if the parts were slid back into their original positions.

Wegener lays some stress on what he considers to be tectonic accordances, such as, along the Atlantic break, those of the Algonkian gneiss ranges of Scotland and of Labrador, the supposed continuation of the Caledonian fold in Newfoundland, and others. Lake[2] has recently pointed out that these supposed accordances are forced and that they can be made to agree only by great and unwarranted distortions. Wegener attempts also some stratigraphic and biological accordances and alludes to the extension of the plateau basalts of East Greenland over Jan Mayen, Iceland, and the Faroe Islands, and to a supposed correspondence between the Deccan Traps of India and basalts of northern Madagascar.

The object of the present note is to examine the question of petrographic accordances, chiefly along both sides of the Atlantic basin, in the light of what is known of the bordering comagmatic regions. Such a region is, by definition, one of cognate igneous rocks, that resemble each other in their general mineral and chemical characters and in their petrographic features. In any area these igneous rocks form the foundation of the surficial and tectonic features; they form

[1] Received July 23, 1923.

[2] P. S. Lake, Geogr. Journ. **56**. 1923.

the main portion of the continental raft, so to speak, which, according to Wegener, drifted across the space now occupied by the Atlantic, bearing a load of sedimentary deposits the surface of which is corrugated or otherwise roughened by mountain building, warping, erosion, and other such dynamical and structural processes. The effects of these processes do not extend to the whole depth of the crystalline igneous sheet. If, therefore, the crack or line of disjunction ran through such a region of chemically and petrographically similar, igneous rocks, we should find on either side of the gap areas of corresponding igneous rocks derived from the basement, even though the sedimentary rocks and the fossils and other stratigraphic features might not be accordant because of surficial changes that may have taken place later than the separation. The following brief discussion is based on the second edition of Wegener's book.[3] Because of the preliminary character of this paper the various statements and descriptions must be put very briefly and only the chief petrographic features can be given. Nearly all references must be omitted. The reader will find most of the data in Iddings' Igneous Rocks, Vol. II, and in Professional Paper No. 99 of the U. S. Geological Survey.

The beginning of the Atlantic split and sliding is supposed to have been in late Cretaceous or early Tertiary time, but it seems reasonable to believe that the time element has little bearing on the phase of the matter that is now under discussion. We are dealing here with the deep-lying igneous basement, as has been said, beneath the relatively very thin skin of sedimentary rocks which record the passage of time by their content in fossils and their very shallow movements. Beneath these the basal masses of igneous material, whether solidified or as liquid "magma reservoirs," must persist in their general characters during and in spite of the epidermal movements above them, the sense of which is up and down or radial for the most part. It may be supposed that the crystalline part of the "crust" which we shall here consider may, at a rough estimate, extend to about 20 miles beneath the surface, possibly rather more according to some estimates.[4]

In considering the Atlantic split let us begin at the northern end, where it is narrowest. Here, according to Wegener's maps, the northwest coast of Norway was jammed against the southeast coast of Greenland, with Iceland squeezed in between the two. We may leave out of consideration the pre-Cambrian gneisses and schists, which belong to the Scandinavian shield. Along the Norwegian coast is much

[3] Alfred Wegener, *Die Entstehung der Kontinente und Ozeane*, Braunschweig, 1920.

[4] Cf. R. A. Daly, *The earth's crust and its stability*, Am. Journ. Sci. **5**: 360–363. 1923.

granite, with some distinctly sodic syenite and some gabbro, and there are several important areas of anorthosite and related rocks as at Bergen. On the east coast of Greenland, as far north as Scoresby Sound, besides the pre-Cambrian gneisses and granites, the rocks are mostly plateau flows of basalt of Tertiary age, which overlie the gneiss, but the extensive Paleozoic granites and syenites, and especially the characteristic anorthosites such as are found in Norway, are very rare or are lacking entirely. Some small areas of rather alkalic rock occur also along the east coast of Greenland, for which there seems to be no corresponding areas in Western Norway, unless possibly the Christiania region around the corner may be so reckoned. Of the plutonic basement of Iceland little or nothing seems to be known. It thus appears that Western Norway and Eastern Greenland do not show signs of correspondence.

On the west coast of Greenland the igneous rocks seem to be mostly dioritic, with here also extensive flows of basalt and several noteworthy areas of highly sodic and very peculiar rocks. Somewhat similar dioritic rocks occur on Ellesmere Land, which is virtually a northwesterly continuation of the west coast of Greenland. But in Baffin Land, which is separated from Greenland by the wide and rather deep Baffin Bay and Davis Strait, similar rocks do not appear to occur, although little is known of the petrography of this region. A large series of rocks mostly from the western and southern parts of Baffin Land, brought back by the McMillan Expedition and entrusted to me for study, are mostly granitic and gneissoid, and evidently belong to the Canadian Shield. No areas of alkalic rocks, corresponding to those of Julianehaab, Ivigtut, etc., and no extensive basalt flows are known from eastern Baffin Land. The evidence therefore, although it is imperfect, is adverse to the idea that Baffin Land was once contiguous with the west coast of Greenland, as has been suggested by Taylor and by Wegener.

In discussing this northern end of the Atlantic split it should be said that the very extensive area of the Tertiary plateau basalts, which are remnants of a land that then covered all the region from eastern (and possibly western) Greenland to the Faroes and Franz Josef Land, which has been called the Thulean region, is evidence that underlying this is a supply of magma of very uniform basaltic composition. The outpouring of these basalt flows is later than the Wegenerian fracture and it might be plausibly argued by a follower of Wegener that they originated in and thus represent the viscous basaltic substratum on which the raft of crystalline crust floated west-

ward, and that the magma was able to come to the surface because of the freedom from pressure brought about by the laying bare of the surface of the lower basaltic layer. This is plausible and ingenious, but it was shown by Geikie, in his work on the ancient volcanoes of Great Britian, that similar lavas were being poured out in the Thulean region as far back as Paleozoic and even pre-Cambrian time. We know also that similar enormous floods of plateau basalts were being poured out elsewhere, as in India, Siberia, and in the northwestern United States, at approximately the same time as those of the Thulean region, and that these other outflows can not be connected with relief of pressure due to sliding of the upper parts of the crust. The Thulean basalts must then be regarded as indecisive.

Farther south we find, according to Wegener's maps, Ireland and Great Britain abutting against Labrador and Newfoundland, and (presumably) France, with the Armorican peninsula, alongside of the Maritime Provinces and New England. An outstanding petrographic feature of Labrador and Newfoundland and eastern Canada is the presence of many large areas of pre-Cambrian anorthosite. Nothing corresponding to them occurs in western Europe, at least in the parts that would correspond with the American occurrences on the Wegener hypothesis, although areas of anorthosite occur in western Norway, as we have seen, these having no corresponding representatives in Greenland. The extensive Triassic "trap sheets" of New England, Nova Scotia, and Labrador also do not have their equivalents in western Europe, except that many such basaltic rocks of various ages occur in Great Britain and Ireland. It is to be noted, moreover, that these more northerly occurrences of Triassic traps in America are but the end members of a long series of plateau extrusions which extends far down through New Jersey and Pennsylvania into the Southern States. This important petrographic feature has no counterpart across the Atlantic. Another marked petrographic feature of New England and eastern Canada is the occurrence of many small areas of decidedly sodic rocks of very early geologic age, most of them east of the Appalachians. Somewhat similar highly sodic areas are present in northern Scotland and elsewhere in the British Isles, but they do not seem to be represented in Labrador and Newfoundland opposite them. Those of the Novanglian Region may be represented by the somewhat alkalic rocks of central France, but these are of much later date and are, furthermore, much less sodic. The dominant feature of the Appalachian region, along the Atlantic coast of the United States, is the abundance of granite which is quite

uniformly characterized by being rather high in both soda and lime and rather low (for granite) in potash. Although much granite exists in the corresponding parts of western Europe it does not show the uniformity in composition that is the striking feature of the Appalachian region.

In the first edition of his book Wegener assumed that France, the Iberian Peninsula, and northwest Africa were conterminous with the southern Atlantic States and the West Indies, but in later editions they are separated by a rather narrow inland sea. The interior of the Iberian Peninsula is largely granitic, but we know practically nothing of these rocks, especially as to their chemical characters. They may or may not correspond to the granites of the Appalachian region, but the different configurations of the two masses is against such a correspondence. Several areas of highly sodic rocks occur in Spain and Portugal, but these do not have any corresponding areas in the most southerly states, South Carolina, Georgia, and Florida, which should have adjoined Portugal, although similar highly sodic areas exist many miles inland and to the west in Arkansas and Texas.

The Lesser Antilles form a region with somewhat peculiar and unusual petrologic features, the volcanic rocks showing as their chief and most notable character simultaneously high silica and lime, although the underlying plutonic igneous foundation appears to be of a more usual character. The Mexican region, to the west, is somewhat similar to the Antillean, especially in its high silica, but is rather more normal. Of the petrology of the west coast of the great African bulge or protuberance we know little, but that little, such as the abundance of basaltic and charnockitic rocks in Liberia, Senegal, and French Guinea, indicates that the eastern shore of the Atlantic in these latitudes is very different from the western.

We come now to the crucial portion of the line of fission—the northeastern corner of South America and the north and east shores of the Gulf of Guinea. The apparent exactness with which the one of these could be fitted into the other first suggested the idea of former juxtaposition and subsequent separation. Unfortunately we know comparatively little in detail of the igneous rocks of much of these two parts of the globe, but we have sufficient knowledge of their broader features to permit us to consider the correspondence or non-correspondence of the rocks as very weighty evidence.

The eastern part of the north littoral of South America, comprising the Guianas and the States of Pará, Maranhao, Ceará, and Rio

Grande do Norte,[5] forms the northern edge of the great Archean "Brazilian Complex," which consists mainly of granite and gneiss, with syenite, quartz porphyry, diabase, and gabbro, as well as various schists. There is no record of any areas of alkalic rocks along this stretch of coast, but the island of Fernando Noronha, near Cape San Roque, is composed of phonolite. The land to the north of the Gulf of Guinea, which according to Wegener formerly adjoined the north coast of South America, seems to be of rather simple petrological character, in this resembling the American counterpart.[6] The basal Archean rocks are mostly granite, but we know little of its chemical characters. There occur also various other plutonic rocks, such as diorite, gabbro, and diabase. Detailed petrographical information regarding this region is rather scanty, but a number of definite and significant facts stand out. The granites of French Guinea and Dahomey are decidedly alkalic and different from the granites of the Guianas. The distinctly sodic tendency of the Nigerian granites is shown by the presence of riebeckite and cassiterite, and tourmaline-bearing granite occurs in Southern Nigeria. In Nigeria also are Tertiary volcanic rocks, among which are phonolite, trachyte, and limburgite, and very peculiar, highly sodic lavas, including nephelinite, leucitite, and hauynophyre, are found at the Etinde Volcano near the coast of British Kamerun. This littoral region has a decidedly sodic tendency, quite distinct from that of northeastern South America, and appears to be connected with a similarly sodic region to the north about Lake Chad and Sokoto. Another feature of this region which is not found in the American one is the comparative abundance of rocks of the "charnockite series" in the Ivory coast, French Guinea, and Liberia. These rocks are characterized by abundant hypersthene, running from hypersthene granite to norite, and greatly resemble the charnockite series of India. It thus seems to be evident that grave petrographical and chemical discrepancies exist between the rocks of the Guiana-Ceará coast and that of Guinea.

The igneous rocks of the eastern coastal states of Brazil, from Parahyba to Paraná, belong mostly to the somewhat monotonous Brazilian complex, and are largely granitic, with some syenite and pyroxenite (as in Bahia) and dikes of diabase. At various points near the coast, in southern Bahia, Minas Geräes, Rio de Janeiro, São Paulo,

[5] Cf. J. B. Harrison, *The geology of the gold fields of British Guiana*, 1908; J. C. Branner, *Outlines of the geology of Brazil*, Bull. Geol. Soc. Amer. **30**: 190–337. 1919, with a geologic map.

[6] For some account of the British portions of this region see F. R. C. Reed, *The geology of the British Empire*, London, 1921, pp. 140–155.

and probably in Espirito Santo, highly sodic rocks occur, including trachyte, phonolite, tinguaite, limburgite, jacupirangite, and nephelite syenite. The rather extensive occurrence of monazite sands along the coasts of Bahia[7] and Espirito Santo indicates the presence of sodic syenitic rocks in the hinterland. The islet of Trindade, about 1300 kilometers east of the coast, is composed of phonolite, according to Branner;[8] this occurrence is probably comagmatically connected with that of phonolite at the Island of Fernando Noronha off Cape San Roque. South of Brazil phonolitic rocks occur in Paraguay and possibly in Uruguay and eastern Argentina. The occurrence of vast sheets of plateau basalt in Paraná and other southern states of Brazil and in Argentina will be discussed later.

Along the west coast of Africa, south of Guinea, and opposite Brazil, Uruguay, and northern Argentina, the dominant igneous rocks appear to be mostly granitic and gneissose, belonging to the African "fundamental complex." Although comparatively little is known of this stretch of coast yet here and there some occurrences of possibly significant rocks are known. Thus, trachyte, phonolite, and trachydolerite are found on the island of São Thomé and they are also probably represented on Fernando Poo, where the lavas are mostly basaltic. These islands lie in the Bight of Biafra at the northeast angle of the Gulf of Guinea where Cape San Roque would fit in. Sodic lavas, aegirite trachyte, phonolite, and nephelinite, occur in Angola, as well as a series of sodic plutonic rocks, including nephelite syenite and shonkinite. Representatives of a fairly well-defined charnockite series, ranging from hypersthene granite to norite, are met with in Benguela. Neither sodic nor charnockitic rocks seem to have been found farther south in the Southwest Africa Protectorate. In the Transvaal there are large areas of nephelite syenite and other sodic rocks described by Brouwer, Shand, and others; but these would appear to belong to the Indian Ocean region rather than to that of the Atlantic.

There are thus found on both sides of the Atlantic, southward from Cape San Roque on the west and from the Bight of Biafra on the east, lines of isolated occurrences of sodic rocks, both plutonic and volcanic, which have been intruded into or poured out over continental basement complexes of apparently quite similar granitic and gneissose rocks. Alkalic, chiefly sodic, rocks occur also in the intervening Atlantic, as at Fernando Noronha and Trindade near Brazil and at Ascension and St. Helena in the southeastern Atlantic. This corre-

[7] I found monazite sand at a bathing beach near the city of Bahia, but observed no syenite in the prevailingly diabasic rocks of the neighborhood.

[8] J. C. Branner, Bull. Geol. Soc. Amer. **30**: 300. 1919.

spondence in occurrence of coastal sodic rocks on both sides might be considered favorable to the Wegener hypothesis, but on the other hand the generally markedly sodic character of the South Atlantic islands may be interpreted with equal plausibility as indicating a generally sodic character for the magmas that underlie the South Atlantic basin and that the coastal occurrences are but marginal effusions from this. The lack of correspondence between the Guiana-Ceará coast and that of Guinea, sodic rocks being absent from the one and quite abundant in the other, seems to constitute more positive and more decisive evidence against the hypothesis. In addition to this is the rather frequent occurrence of charnockitic rocks along the African side of the Atlantic and their absence from the American side. The balance of the petrographical evidence, may, then, be regarded as adverse to Wegener's hypothesis.

Before leaving the southern part of the Atlantic split another feature should be considered. In the Transvaal and Cape Colony, and extending north into Rhodesia, enormous areas are covered with the plateau basalts of the late or post-Karroo (Triassic) Stormberg or Drakensberg series, and what are probably analogous plateau flows of about the same age are found in the Kaokoveld, near the coast, in northwestern ex-German Southwest Africa. Across the South Atlantic, in the states of Paraná, São Paulo, Santa Catarina, and Rio Grande do Sul in Brazil, in Uruguay, and in southern Argentina (Patagonia), enormous areas are covered with similar plateau basalts of generally Triassic age. These vast flows have not been sufficiently studied, as yet, to permit any detailed chemical or petrographical correlation. But their occurrence as a petrographical feature of the first magnitude common to both sides of the South Atlantic is of great interest and is apparently favorable to the Wegener hypothesis. To judge from their geologic age they would seem to have been extruded on both sides, in general, shortly before the beginning of the split, if I understand Wegener correctly. If his hypothesis be true, however, we would expect, on the analogy of the Thulean basaltic area of the North Atlantic, to find many basaltic islands in the ocean between the two sides of the fracture, because of the relief of pressure and exposure of the underlying basaltic substratum brought about by the westward sliding of the American continental mass. This, however, is not the case. There are very few islands in the South Atlantic and these show dominantly sodic and not sodi-calcic (basaltic) characters. These vast plateau extrusions of probably similar basalts in South Africa and in southern South America seem to me more justifiably interpreted as belonging to a general and widespread event or cyclical incident in the earth's history, strictly analogous

to the similar plateau basalt areas of the Deccan, Thulean, Oregonian, Palisadan, and Siberian regions.[9]

In this preliminary sketch of the relation of various comagmatic regions to the main features of the Atlantic area, expecially as regards the Wegener hypothesis, it seems to be scarcely necessary to discuss the relations in other parts of the earth (Lemuria, for example) mentioned by Wegener in the course of his discussions. Mention may be made, however, of a minor point in Wegener's argument.[10] This is that he believes that the Pacific volcanic islands are "fragments of the lithosphere and that they are in so many cases so completely covered with lava that the lithospheric core is not visible." Were this true the upper side of the basal fragment of the lithosphere should be not far below or at the surface of the ocean and we would expect to find, as we do at many other volcanoes, fragments of granite, gneiss, or other basement rocks as inclusions in the lavas.

In the course of a recent study of the lavas of the Hawaiian islands a very large number of specimens have been examined but not a single inclusion of such igneous or metamorphic rocks, or of limestones or sandstones, has been found. The only xenoliths that the Hawaiian lavas contain are of dunite, lherzolite, pyroxenite, or gabbro—all evidently cognate inclusions (enclaves homoeogènes of Lacroix) produced by magmatic segregation in the basalts. Lacroix[11] has recently shown that the supposed granite of Bora-Bora in the Society Islands is a medium-grained olivine gabbro, either intrusive into the abundant basalts of the island or (as seems to me to be more probable) a cognate inclusion like those of the Hawaiian Islands. A somewhat extensive search through the literature on the petrography of the volcanic islands of the Pacific has not revealed any example of inclusions of granitic or other continental rocks. Wegener's suggestion may therefore be regarded as unsupported by evidence.

ZOOLOGY.—Gonorhynchus moseleyi, *a new species of herring-like fish from Honolulu.* DAVID STARR JORDAN AND JOHN OTTERBEIN SNYDER.

Gonorhynchus moseleyi Jordan and Snyder, new species

Description of the type, No. 23239, Stanford University collection, a specimen 140 millimeters long from Honolulu, T. H., collected by Edwin Lincoln Moseley, professor of Biology in the State Normal School at Bowling Green, Ohio.

9 H. S. Washington, *Deccan traps and other plateau basalts*, Bull. Geol. Soc. Amer. **33**: 765. 1922.

10 A. Wegener, *Die. Entstehung der Kontinente und Ozeane*, 2 ed., 1920, p. 42, note 1.

11 Lacroix, *Le soi-disant granite (gabbro à olivine) de l'île Bora-Bora*, C. R. Soc. Géol. France, 1916, p. 178.

Head 4.1 in length to base of caudal; depth 9.2; depth caudal peduncle 4.5 in head; depth head 2.6; length snout 2.5; diameter eye 4; width interorbital space 3.7; length pectoral fin 1.3; ventral fin 2.2; height dorsal 2.1; anal 2.4; length caudal 1.8; scales lateral series to base of caudal 166; vertical series between lateral line and middle of back 22; pectoral rays 11; dorsal 9; ventral 9; anal 7.

Length of barbel equal to diameter of pupil, extending when depressed over half way between its base and border of lower lip. Upper lip with many rows of tubercles, the edge fringed with papillae. Lower lip covered with small tubercles and with pendent lobes which extend posteriorly.

Gillrakers long and slender 17 plus 19 on the first arch.

Head and body almost completely scaled, the scales extending over throat to edge of lip, under part of snout, and along the rays of all the fins. Tip of snout, lips, and opercular membrane naked. The scales are long and slender with 9 spines on the exposed ends.

Pectoral and ventral fins with pointed axillary flaps over half as long as the fins; the outer surfaces of which are covered with scales. Pectoral fins pointed, appearing acute when depressed, ventrals rounded, edge of dorsal convex on the anterior, concave on the posterior half, caudal notched.

Color in spirits gray above, lighter below, the dark color resulting from numerous closely opposed black specks. Pectoral fins largely black, bordered by white; dorsal and caudal broadly edged with black, ventrals black, edged with white, the dark area appearing as a well defined black oval spot when the fin is not spread; anal immaculate. Lining of gill chamber black, the color showing through the translucent opercle. The bases of pectorals and ventrals were bright yellow when the specimen was fresh.

This dainty little fish was found by Moseley in the market of Honolulu, where he made a valuable and interesting collection of fishes.

It is closely related to the two known species of the genus, *Gonorhynchus gonorhynchus* (Gmelin) from the Indian-Australian region and *Gonorhynchus abbreviatus* Schlegel from Japan.

The Hawaiian species differs from both these in having a much larger eye and a longer head. The color of the ventral fins differs also, those of *G. moseleyi* having a large sharply defined central oval black blotch, not covering the posterior part of the fin as in the others.

Comparisons follow with *Gonorhynchus gonorhynchus* from Port Jackson and Lord Howe Islands and *G. abbreviatus* from Yokohama.

	HAWAII (*G. moseleyi*)	LORD HOWE ISLAND *G. gonorhynchus*		PORT JACKSON *G. gonorhynchus*	YOKOHAMA *G. abbreviatus*
Length to base of caudal in millimeters	124	122	89	217	250
Depth body in hundredths of length	0.11	0.11	0.10	0.115	0.125
Depth caudal peduncle	0.058	0.05	0.05	0.058	0.056
Length head	0.26	0.245	0.24	0.21	0.22
Length snout	0.10	0.095	0.098	0.08	0.095
Diameter eye	0.065	0.05	0.05	0.045	0.05
Width interorbital area (skull)	0.035	0.025	0.023	0.03	0.035
Dorsal rays	9	10	10	11	8
Anal rays	7	7	7	7	6
Pectoral rays	11	10	9	10	11
Ventral rays	9	9	9	9	8

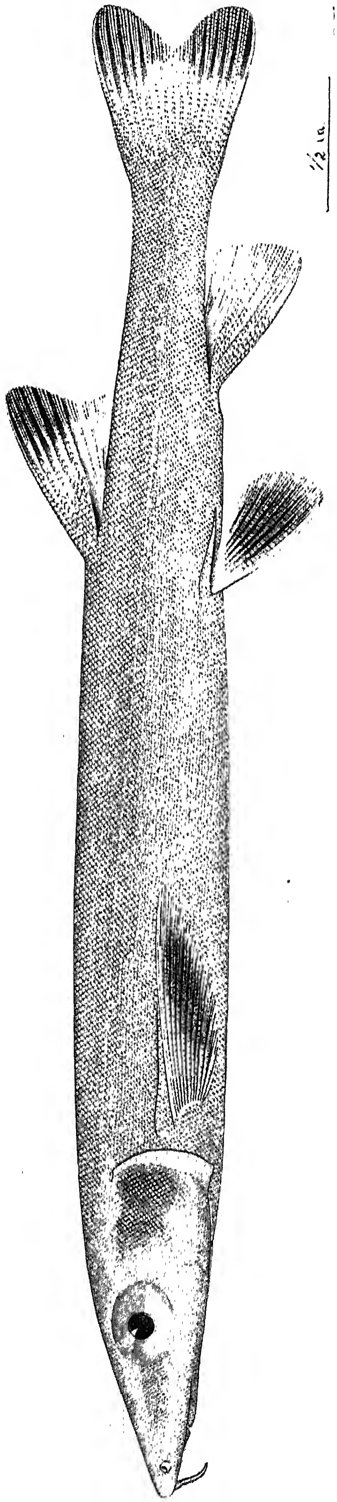

Fig. 1. Gonorhynchus moseleyi Jordan and Snyder

There appear to be no differences in the number of the scales. With age, the scales seem to grow laterally, the spinules increasing in number to 19 or more.

BOTANY.—*Ten new species of trees from Salvador.*[1] PAUL C. STANDLEY, U. S. National Museum.

The ten species of trees here described all occur in the Republic of Salvador, but some of them extend also to other parts of Central America. Part are based upon specimens obtained by the writer during the winter of 1921–22, and others upon material collected by Dr. Salvador Calderón of the Salvadorean Department of Agriculture. One of the three described is of some importance locally as a source of lumber, while another represents a genus not reported previously from North America.

Pseudolmedia mollis Standl., sp. nov.

Large tree, the young branchlets densely fulvous-pilose; petioles very thick, 4 to 6 mm. long; leaf blades oblong or narrowly ovate-oblong, 11 to 16 cm. long, 4 to 6.5 cm. wide, somewhat abruptly acuminate, obliquely rounded at base, subcoriaceous, glabrate above except along the nerves, the venation depressed, beneath paler, copiously soft-pilose, especially along the costa and lateral nerves, the venation elevated, the lateral nerves about 15 pairs, arcuately ascending, anastomosing near the margin; fruit globose-oval, 2 cm. long, densely soft-pilose, subtended at base by few broadly ovate, acutish bracts.

Type in the U. S. National Herbarium, no. 1,152,341, collected at Comasagua, Salvador, December, 1922, by Dr. Salvador Calderón (no. 1382).

The leaves resemble in shape and texture those of *P. oxyphyllaria* Donn. Smith, the only other species of the genus known to occur in Central America, but the pubescence is altogether different in the two species. The vernacular name of the Salvadorean tree is "tepeujushte."

Ledenbergia macrantha Standl., sp. nov.

Tree, about 6 m. high, with long, somewhat pendent branches; young branchlets sparsely tomentulose, soon glabrate; petioles slender, 2 to 4.5 cm. long, sparsely villosulous; leaf blades elliptic or broadly ovate, 4.5 to 8 cm. long, 2.5 to 4.5 cm. wide, acuminate, acute or obtuse at base, thin, glabrous above, beneath villosulous along the costa near the base, elsewhere glabrous racemes very numerous and forming a dense panicle, their rachises 12 to 20 cm. long, tomentulose; pedicels filiform, 5 to 10 mm. long; sepals oblong-oblanceolate, in fruit 8 to 13 mm. long, 3 to 4.5 mm. wide, glabrate, conspicuously veined; fruit glabrate, rugulose, 3 mm. long.

Type in the U. S. National Herbarium, no. 1,111,202, collected along roadside at Puerta de la Laguna, near San Salvador, Salvador, February 24, 1923, by Dr. Salvador Calderón (no. 680). The following additional specimens have been seen:

[1] Published by permission of the Secretary of the Smithsonian Institution.

SALVADOR: Puerta de la Laguna, *Standley* 23656; April 27, 1922, *Calderón* 680 (both these collections are from the type tree). Department of Ahuachapán, *Padilla* 195.

Dr. Padilla gives the vernacular name as "nevado."

Until very recently, only a single species of *Ledenbergia* was known, *L. seguieriodes* Klotzsch of Venezuela. During the present year there has been published a second species, *L. peruviana* O. C. Schmidt, of Peru. The Salvadorean tree differs from the South American ones in having flowers twice as large as theirs.

Hyperbaena phanerophlebia Standl., sp. nov.

Tree, 4.5 to 7.5 m. high, with dense crown, glabrous throughout; petioles rather slender, 1 to 2.5 cm. long; leaf blades narrowly oblong or oblong-lanceolate, 9 to 21 cm. long, 3 to 7 cm. wide, narrowed to an obtuse apex, obtuse or acute at base, thick and coriaceous, lustrous, triplinerved from near the base, the costa salient on both surfaces, the lateral nerves scarcely elevated above but conspicuous beneath, about 5 pairs, arcuately and irregularly ascending, the lower surface slightly paler than the upper and finely reticulate; fruit subglobose, orange-yellow, about 2.5 cm. in diameter.

Type in the U. S. National Herbarium, no. 1,138,730, collected in a coffee plantation in the hills south of Santa Tecla, Salvador, altitude about 900 meters, April 10, 1922, by Paul C. Standley (no. 23025). Also collected in moist forest near Santa Tecla upon the same date, *Standley* 23014.

This is not closely related to any of the species of *Hyperbaena* previously reported from Central America.

Rollinia rensoniana Standl., sp. nov.

Tree, about 6 m. high, the young branchlets thinly villous-tomentose; petioles 6 to 12 mm. long; leaf blades elliptic-oblong, 12 to 23 cm. long, 5 to 8 cm. wide, acute to long-acuminate, rounded or obtuse at base, thin, above tomentulose when young but in age glabrate, beneath densely tomentose at first with brownish and whitish hairs, in age soft-pilose with short spreading hairs, the lateral nerves 15 to 21 pairs, prominent beneath; flowers solitary or geminate, densely covered with a brownish feltlike tomentum, the pedicels 1 to 2 cm. long, becoming much longer after anthesis; sepals broadly rounded-ovate, abruptly short-acuminate; corolla lobes laterally compressed, obovate-oval, 10 to 13 mm. long, 7 to 9 mm. wide, broadened toward the apex and rounded, divaricate or slightly ascending; very immature fruit tomentose, subglobose, composed of numerous carpels with rounded tips.

Type in the U. S. National Herbarium, no. 1,138,729, collected along roadside at Santa Tecla, Salvador, altitude about 900 meters, April 10, 1922, by Paul C. Standley (no. 23033). The following additional specimens have been examined:

SALVADOR: Ateos, *Standley* 23045. Izalco, *Standley* 21866; *Pittier* 1964.

Rollinia rensoniana seems to be rather common in the uplands of central and western Salvador, but I was not able to learn anything of its fruit or of the vernacular names applied to it. Only two other species have been reported from Central America, *R. jimenezii* and *R. pittieri*, both described by Dr. W. E. Safford. Neither of those species has the abundant spreading pubescence that characterizes the Salvadorean tree.

The species is named for Dr. Carlos Renson, of the Chemical Laboratories of the Department of Agriculture of Salvador, who, during many years residence in that country, has made important contributions to our knowledge of its botanical features.

Inga calderoni Standl., sp. nov.

Young branchlets densely pilose with short fulvous hairs; leaf rachis 5.5 to 9 cm. long, narrowly winged, densely short-pilose; leaflets 5 or 6 pairs, narrowly oblong-lanceolate, 7 to 10.5 cm. long, 1.5 to 2.2 cm. wide, long-attenuate, obliquely obtuse or rounded at base, copiously fulvous-pilose above with subappressed hairs, beneath more densely pilose with mostly spreading hairs; legume oval-quadrate, 5 cm. long, 3.5 cm. wide, strongly compressed, nearly 1 cm. thick, covered with a dense feltlike tomentum of stiff fulvous hairs.

Type in the U. S. National Herbarium, no. 1,152,344, collected at Comasagua, Salvador, December, 1922, by Dr. Salvador Calderón (no. 1392).

The form of the fruit is quite unlike that of any other species of *Inga* known from Central America. The vernacular name is "pepeto de mico."

Cupania mollis Standl., sp. nov.

Branchlets subterete, finely tomentose, somewhat striate, glabrate in age; leaves abruptly pinnate, the rachis and petiole together about 23 cm. long, finely tomentose; leaflets about 14, oblong or elliptic-oblong, 8 to 13 cm. long, 3.5 to 5 cm. wide, obtuse, rounded or obtuse at base, on petiolules 3 to 8 mm. long, serrate with low appressed teeth, entire toward the base, glabrate above, beneath paler, densely velvety-pilosulous with short spreading hairs; panicles axillary, long-pedunculate, many-flowered, the branches finely tomentose; flowers sessile or nearly so; capsule glabrous without and within, subclavate-trigonous, narrowed below into a stout stipe 5 to 6 mm. long, the body obtusely angulate, 12 to 15 mm. in diameter, rounded and apiculate at apex, the partition walls thin.

Type in the U. S. National Herbarium, no. 1,152,345, collected at Comasagua, Salvador, December, 1922, by Dr. Salvador Calderón (no. 1400).

The fruit is similar to that of *C. glabra* Swartz, but the pubescence of the leaves is altogether different. The vernacular name is "cola de pavo," a name applied to various other trees of the family Sapindaceae.

Karwinskia calderoni Standl., sp. nov.

Shrub or tree, 2 to 12 m. high, glabrous throughout; petioles 7 to 12 mm. long; leaf blades lance-oblong or sometimes oblong-ovate, 3.5 to 10 cm. long, 1.5 to 3.5 cm. wide, rounded at base, acute to long-acuminate at apex, green above, pale beneath, the lateral nerves 7 to 14 pairs, elevated beneath; peduncles sometimes 6 mm. long but usually much shorter, often bifurcate above the middle, each branch bearing a few-flowered umbel, the pedicels 1.5 to 4 mm. long; flowers 3 to 4 mm. broad; fruit subglobose, black and lustrous, 6 to 7 mm. long.

Type in the U. S. National Herbarium, no. 1,151,861, collected at Aculhuaca, one of the suburbs of San Salvador, Salvador, July 14, 1922, by Dr. Salvador Calderón (no. 900). The following additional specimens have been examined:

GUATEMALA: Estanzuela, Dept. Santa Rosa, *Heyde & Lux* 3954. Berberena, Dept. Santa Rosa, *Heyde & Lux* 6088. Without locality, *Heyde* 192. Gualán, *Kellerman* 5610.

SALVADOR: Tonacatepeque, *Calderón* 214; *Standley* 19467. San Salvador, *Standley* 19118, 23544; *Calderón* 420. Armenia, *Standley* 23451. Ahuachapán, *Standley* 19901. La Libertad, *Standley* 23225. Between San Martín and Laguna de Ilopango, *Standley* 22528. La Unión, *Standley* 20650. Dept. de Ahuachapán, *Padilla* 186. Without locality, *Renson* 265. San Vicente, *Standley* 21665. Santa Ana, *Standley* 20427.

HONDURAS: Amapala, *Standley* 20697.

NICARAGUA: Aserradores Island, *Baker* 625.

Karwinskia calderoni is the only species of which I have seen Central American specimens. It is related to *K. humboldtiana* of Mexico, but is evidently distinct in the acuminate leaves and the frequently if not usually bifurcate peduncles. In Salvador it is known as "güiligüiste" or "huilihuiste," and at Ampala the name "pimientillo" was given for it. The tree is extremely abundant in the drier portions of the Pacific slope of Central America, occurring usually on dry hillsides at low or middle elevations. It is found also on the Atlantic slope of Guatemala. The wood is employed for various purposes, particularly for cart axles, railroad ties, mallets, shuttles, and fuel. Pigs are said to be paralized by eating the fruit, and similar properties are generally ascribed to the Mexican species.

Clethra vicentina Standl., sp. nov.

Tree, about 9 m. high, with dense rounded crown; young branchlets fulvous-tomentose or glabrate; petioles 7 to 15 mm. long; leaf blades oblanceolate-oblong, 8 to 12 cm. long, 2.5 to 3.5 cm. wide, obtuse, attenuate to the base, subcoriaceous, entire, green and glabrous above, covered beneath, except upon the nerves, with a very fine, close whitish tomentum; racemes numerous, 12 to 15 cm. long, the rachis slender, closely fulvous-tomentose, the pedicels slender, 3 to 5 mm. long; calyx lobes ovate-oval, 3.5 to 4 mm. long, obtuse, tomentulose; petals white, 5 to 6 mm. long, erose and ciliate; style 1.5 mm. long.

Type in the U. S. National Herbarium, no. 1,137,375, collected in moist forest on the Volcán de San Vicente, Salvador, altitude 1,500 meters, March 8, 1922, by Paul C. Standley (no. 21603).

Related, apparently, to *C. hondurensis* Britton, in which the leaves are broader and dentate, and the calyx lobes acute.

Clethra vulcanicola Standl., sp. nov.

Tree, 4.5 to 6 m. high, the young branchlets bearing a few appressed hairs but soon glabrate; petioles 7 to 12 mm. long; leaf blades oblanceolate-oblong or obovate-oblong, 9 to 12 cm. long, 2.5 to 4.5 cm. wide, acute or acuminate, acute or obtuse at base, coarsely serrate, glabrous above, green beneath and glabrous except for a few stiff, usually appressed hairs along the costa and lateral nerves; racemes 10 to 13 cm. long, the rachis fulvous-tomentose, the pedicels slender, 5 to 6 mm. long; calyx lobes 3 mm. long, ovate, obtuse, fulvous-tomentulose; capsule 6 to 7 mm. in diameter, tomentose.

Type in the U. S. National Herbarium, no. 1,138,667, collected on the rim of the crater of the Volcán de San Salvador, altitude about 1,800 meters, April 7, 1922, by Paul C. Standley (no. 22954).

Similar in general appearance to *C. alcoceri* Greenm., of Hidalgo, but in that species the pedicels are very short and the leaves are white-tomentulose beneath. *Clethra suaveolens* Turcz. is more closely related, but in that the leaves are entire. The vernacular name of *C. vulcanicola* is "zapotillo."

Avicennia bicolor Standl., sp. nov.

Tree or shrub, the young branchlets glabrous; petioles very stout, 4 to 15 mm. long; leaf blades broadly elliptic to elliptic-ovate or oval-ovate 7 to 13 cm. long, 3.5 to 7 cm. wide, rounded or obtuse at apex, obtuse at base and usually abruptly short-decurrent, glabrous and lustrous above, with prominent venation, beneath densely covered with a minute whitish tomentum; flowers spicate, opposite, the rachis elongate and the pairs of flowers distant 5 to 8 mm. from each other, the spikes numerous, forming lax panicles 5 to 17 cm. long; branches of the panicles minutely tomentose; bracts and bractlets rounded, obtuse, tomentulose; corolla 4 mm. long, the tube glabrous, the lobes obovate, subtruncate at apex, sericeous outside, glabrous within; style nearly obsolete.

Type in the U. S. National Herbarium, no. 715142, collected in mangrove swamp at Aguadulce, Province of Coclé, Panama, December 5, 1911, by H. Pittier (no. 4968). The following additional specimens have been examined:

SALVADOR: Coast of Departamento de Ahuachapán, *Padilla* 333.

PANAMA: Punta Paitilla, *Heriberto* 206.

It seems remarkable that a form so distinct as this should not have been named long ago, but it may well be that it is of somewhat rare occurrence, although the specimens cited indicate that it has a rather wide range. *Avicennia bicolor* is related to the South American *A. tomentosa* Jacq. (which has been reported from various parts of Mexico and Central America, and even from Florida, although probably erroneously), but differs in its large, broad leaves and, more conspicuously, in the distinct form of the inflorescence. In *A. tomentosa* the flowers are few and the inflorescence is short and congested.

Dr. Padilla reports that in Salvador this species is known by the vernacular name of "mangle negro."

BOTANY.—*New species of Urticaceae from Colombia.*[1] ELLSWORTH P. KILLIP, U. S. National Museum.

While on a recent expedition to Colombia for the U. S. National Museum, the Gray Herbarium, the New York Botanical Garden, and the Philadelphia Academy of Sciences, Dr. Francis W. Pennell and myself gave particular attention to the family Urticaceae, collecting about 70 numbers of this group. Most of the species here proposed as new are based upon material collected on this expedition, which clearly are not referable to any of the species contained in the comprehensive monograph of Urticaceae by Weddell,[2] or to the comparatively small number described since the publication of that work. Several other specimens collected on this expedition probably constitute new species, but in the absence of authenticated material they have not been included in the present paper.

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] In DC Prodr. 16[1]: 32–235. 1869.

The genus *Pilea*, to which most of the following plants belong, contains over 200 species, the greater part of them occurring in the tropics of the New World. Weddell devides the genus into three main groups, *Integrifoliae*, *Heterophyllae*, and *Dentatae*. The last consists of two sections, containing those species that are glabrous, with either long or short peduncles, and those that are pubescent, with either long or short peduncles. This method of classification is followed here.

Pilea filicina Killip., sp. nov.

Plants frutescent, scandent (?), apparently dioecious, pinnately branched (branches divaricate, 10 to 20 cm. long), glabrous throughout. Stems and branches slightly angulate, faintly winged on the angles. Stipules minute, early deciduous. Leaves of a pair dissimilar and unequal, the larger ovate-orbicular, 10 to 13 mm. long, 6 to 7 mm. wide, abruptly tapering at base, sessile or subsessile, crenate at apex (2 teeth to a side, the apical tooth blunt, 2 mm. wide), otherwise entire, penninerved (4 to 6 nerves to a side, one of the pairs often conspicuous, extending to the lower of the teeth), the smaller leaves broadly orbicular, 4 to 5 mm. long, 5 to 6 mm. wide, sessile, entire or slightly undulate at apex, triplinerved; both kinds of leaves dark green (nearly black when dry) and faintly marked with linear cystoliths (especially near margin) on upper surface, paler and copiously covered with minute punctiform cystoliths beneath. Pistillate heads subglobose, minute, 1 to 1.5 mm. wide, 3 or 4-flowered, sessile or very short-petioled; perianth divisions unequal, the middle 0.8 mm. long, the lateral 0.3 mm. long; achenes broadly ovate, 1 mm. long, 0.8 mm. wide.

Type in the U. S. National Herbarium, no. 1,124,280, collected at Paime, Department of Cundinamarca, Colombia, in 1921, by Brother Ariste-Joseph (no. A927).

The venation, markings, and coloration of the leaves of this species indicate a relationship with *P. dendrophila* Miq., but the much smaller leaves, the larger kind being much rounder, and its habit of growth and branching clearly show that it is distinct. From *P. trichosanthes* Wedd., to which also it is allied, it is distinguishable by its more orbicular, nearly sessile, longer leaves which are only faintly marked with cystoliths, and by its more abundant, divaricate branches.

Pilea hazeni Killip, sp. nov.

herb, monoecious (?), glabrous throughout. Stripules ovate-orbicular, 4 mm. long, cordate at base, chartaceous, light brown. Leaves dark green above, bearing fusiform and linear cystoliths, light green beneath with more conspicuous fusiform cystoliths, 3-nerved to upper third of blade; leaves of a pair unequal and dissimilar, the larger ovate-lanceolate, 3 to 4.5 cm. long, 1.5 to 2 cm. wide, short-acuminate at apex, rounded, subcordate, or subcuneate at base, crenate-serrate (teeth averaging 9 to a side), their petioles 1 to 2 cm. long, the smaller leaves nearly orbicular in general outline, 1 to 1.8 cm. long, 1.5 to 2 cm. wide, abruptly acute at apex, rounded or subtruncate at base, crenate-serrate (teeth averaging 6 to a side), their petioles 5 to 7 mm. long. Staminate heads not seen. Pistillate heads cymose, borne in two's or three's in the axils of the upper leaves, the cymes 3 to 4 mm. wide, the peduncles 4 to 5 mm. long; achenes ovate.

Type in the U. S. National Herbarium, no. 1,140,920, collected in the forest along the Río Santa Rita, near Salento, Department of Caldas, Colombia, altitude 1,600 to 1,800 meters, August 26, 1922, by E. P. Killip and T. E. Hazen (no. 10121).

Killip & Hazen no. 9007, collected at essentially the same locality, is also of this species.

Pilea hazeni clearly should be placed in the section *Heterophyllae*, though it differs greatly from any of the described species of that group.

Pilea puracensis Killip, sp. nov.

Erect herbs, 30 to 40 cm. high, glabrous throughout. Stipules triangular-ovate, 3 mm. long. Petioles angulate, those of a pair unequal, the longer 3.5 to 5 cm. long, the shorter 2.5 to 4.5 cm. long. Leaf blades elliptic or elliptic-lanceolate, 10 to 15 cm. long, 3.5 to 6.5 cm. wide, acuminate at apex, rounded or subauriculate at base, closely crenate-serrulate to base (serrulations about 1 mm. long), 3-nerved to apex, penniveined along nerves, faintly covered on both surfaces with punctiform and linear cystoliths. Staminate inflorescence subdichotomously branched, 3 to 6 cm. long, the flowers borne in few-flowered clusters at the ends of the branches. Pistillate inflorescence of sessile, paniculately branched cymes, much shorter than the petioles; perianth-segments unequal, the middle oblong, 0.7 mm. long, the lateral orbicular, 0.2 mm. long; achenes ovate, 1 mm. long.

Type in the U. S National Herbarium, no. 1,140,081, collected in the forest at "Canaan," on the slopes of Mt. Puracé, Department of El Cauca, Colombia, altitude 3,100 to 3,300 meters, June 13, 1922, by F. W. Pennell and E. P. Killip (no. 6673).

Closely related to *P. pteropodon* Wedd., this species is distinguished by smaller leaves and smaller pistillate heads, and by the fact that its leaves do not taper into winged petioles. The foliage and general aspect of the plant suggest *P. quichensis* Donn. Smith, of Guatemala, but the staminate inflorescence is much longer and the leaves are more finely toothed.

Pilea ornatifolia Killip, sp. nov.

Plants dioecious, glabrous throughout, erect or decumbent, the branches lax. Stem succulent, geniculate at the middle of the internodes, reddish brown, without cystoliths. Stipules ovate, 2 mm. long. Leaf blades ovate, acute at apex, obliquely cordate at base, sharply serrate from base to apex, 3-nerved, (lateral nerves reaching the apex), dark green with punctiform cystoliths above, paler with conspicuous linear cystoliths beneath, penni-veined along each nerve, the veins black; leaves of a pair similar but unequal, the larger 4.5 to 5.5 cm. long, 1.5 to 2.5 cm. broad, their petioles 1 to 1.5 cm. long, the smaller 2.5 to 3.5 cm. long, 1 to 1.5 cm. broad, their petioles 2 to 3 mm. long. Staminate heads globose, about 6 mm. in diameter, densely flowered, borne on slender peduncles 2 to 2.5 cm. long; perianth violet-tinged, its lobes 0.5 mm. long. Pistillate heads 4 to 8-flowered, in short axillary cymes, borne on peduncles 4 mm. long; perianth segments subequal, about 1.2 mm. long; achenes broadly ovate, 1.5 mm. long.

Type in the U. S. National Herbarium, no. 1,140,933, collected in an open gulch in the forest on Cerro Tatamá, Department of Caldas, Colombia, altitude 3,200 to 3,400 meters, September 8 to 10, 1922, by F. W. Pennell (no. 10476).

Pilea ornatifolia is allied to *P. flexuosa* Wedd., the principal points of difference being smaller and proportionately narrower leaves of *P. ornatifolia*, with distinctly cordate bases and inconspicuous cystoliths on the upper surfaces, shorter petioles, the much shorter lobes of the staminate flowers, and the shorter segments of the perianth of the pistillate flowers.

Pilea pennellii Killip, sp. nov.

Plants monoecious, slender, branching near the base, 25 to 30 cm. high, glabrous throughout. Stipules triangular, barely 1 mm. long, acute. Petioles 5 to 8 mm. long, those of a pair slightly unequal. Leaf blades narrowly ovate-oblong, 2 to 3 cm. long, 0.8 to 1.5 cm. wide, acuminate at apex, tapering at base, minutely serrulate (teeth acute, imbricate, often cartilaginous at margin), 3-nerved (lateral nerves reaching to the upper quarter of the blade), light green on both surfaces, above copiously covered with punctiform and very minute linear cystoliths, beneath punctate with dark ocellae but almost destitute of cystoliths. Staminate heads globose, 5 to 6 mm. in diameter, purplish white, borne on slender peduncles 3 cm. long, the perianth lobes barely 0.1 mm. long. Pistillate flowers in closely flowered cymes, subsessile or with peduncles up to 3 mm. long, the segments unequal, the middle 0.7 mm. long, the lateral 0.4 mm.; achenes ovate, 0.5 mm. long.

Type in the U. S. National Herbarium, no. 1,140,923, collected in a forest along the Río San Rafael, below Cerro Tatamá Department of Caldas, Colombia, altitude 2,200 to 2,500 meters, September 7 to 11, 1922, by F. W. Pennell (no. 10326).

This species apparently is nearest *P. flexuosa* Wedd., differing in its smaller, closely serrulate leaves, and in its cystoliths. The light green aspect of the plant suggests *P. cuprea* Krause, but in that species the pistillate heads as well as the staminate are long-peduncled.

Pilea rhombifolia Killip, sp. nov.

Plants 20 to 30 cm. high, glabrous throughout. Stipules ovate, 2 to 3 mm. long. Petioles 0.5 to 1.5 cm. long. Leaves of a node similar in shape, subequal in size, rhombic or broadly ovate, 2 to 4.5 cm. long, 1.5 to 3 cm. wide, short-acuminate at apex, cuneate or subrotund at base, crenate-serrate above the base (6 to 7 teeth on a side), 3-nerved (nerves reaching to upper third of blade), subcoriaceous, dark green, slightly lustrous above, silvery-white beneath, copiously covered on upper surface with linear and fusiform cystoliths on lower surface confined mainly to the nerves. Pistillate head in cymes 1 cm. wide or less, the peduncles 0.5 to 1 cm. long; achenes ovate, 1 mm. long.

Type in the U. S. National Herbarium, no. 533,540, collected near Santa Marta, Colombia, altitude 1,750 meters, by H. H. Smith (no. 1446). A specimen of this collection is also in the herbarium of the Academy of Natural Sciences, Philadelphia.

This species is allied to *P. sessiliflora* Wedd. and *P. radicans* Wedd., differing from the former in its relatively broader leaves with larger teeth and more abundant cystoliths, and from the latter in its larger, thicker leaves and erect habit.

Pilea purpurea Killip, sp. nov.

Stems erect, 40 to 60 cm. high, angulate, glabrous below, slightly pubescent above. Petioles 1.5 to 3 cm. long, ferruginous-tomentose, becoming glabrate.

Leaf blades ovate or oblong, 8 to 12 cm. long, 4 to 5 cm. wide, acuminate (acumen 1 cm. long), rounded at base, finely serrate (teeth obtuse), 3-nerved to apex (nerves depressed on upper surface, with numerous pairs of parallel secondary nerves along each primary nerve), the upper surface dark green, glabrous, bearing faint linear cystoliths, the lower surface paler, densely tomentulous on the nerves and veins, destitute of cystoliths but conspicuously punctate between the veins. Staminate cymes up to 15 cm. long, borne in pairs in the axils of the upper leaves, profusely dichotomous, the peduncles and branches densely tomentulous; bracts unusually large for the genus, white; calyx globose, 1 mm. in diameter, white proximally, dark purple distally, its lobes minute. Pistillate cymes subsessile in the axils of the lower leaves, shorter than the petioles; middle segment of perianth obovate, 1.5 mm. long, the lateral segments broadly ovate, 1 mm. long; achenes broadly ovate, 2 mm. long, the margin thickened.

Type in the U. S. National Herbarium, no. 1,140,930, collected in a moist forest along the Río San Rafael, below Cerro Tatamá, Department of Caldas, Colombia, altitude 2,600 to 2,800 meters, September 7 to 11, 1922, by F. W. Pennell (no. 10380).

This is allied to *P. hirsuta* Wedd., differing chiefly in its larger staminate and smaller pistillate inflorescences, in the prominent bracts subtending the staminate flowers, and in the closer serrations of the leaves.

Pilea tatamensis Killip, sp. nov.

Plants dioecious. Stem. repent, at length erect, simple or branching toward the summit, hirsute throughout. Stipules ovate-lanceolate, 7 to 9 mm. long. Leaf blades flat or often slightly rugose, sharply serrate (teeth 2 mm. long), triplinerved (lateral nerves originating 3 to 4 mm. above base and extending to upper third of blade), the upper surface dark green, glabrous, bearing (except along nerves and veins) minute linear cystoliths, beneath paler, densely appressed-hirsute on the nerves and veins, sparsely hirsute elsewhere, the cystoliths fewer and less conspicuous than on upper surface; leaves of a pair unequal and slightly dissimilar, the larger ovate or elliptic-ovate, 3 to 6 cm. long, 2 to 2.5 cm. wide, acute at apex, obliquely cuneate at base, the smaller ovate, 2 to 3 cm. long, 1 to 1.5 cm. wide, rounded or subacute at apex, rounded or subcuneate and oblique at base. Staminate heads globose, 1 cm. in diameter, pilosulous, densely flowered, the peduncles 1 to 1.5 cm. long, hirsute; calyx lobes filiform, 2 to 2.5 mm. long. Pistillate heads cymose, 1 to 1.5 cm. broad, glabrescent, the peduncles longer than the petioles; achenes ovate, 1 mm. long.

Type in the U. S. National Herbarium, no. 1,140,928, collected in moist forest along the Río San Rafael, below Cerro Tatamá, Department of Caldas, Colombia, altitude 2,600 to 2,800 meters, September 7 to 11, 1922, by F. W. Pennell (no. 10378; staminate plants). The pistillate plants are represented by Pennell 10375 (U. S. Nat. Herb. 1,140,925).

In habit and general aspect this plant resembles *P. fallax* Wedd. It is differentiated by larger leaves with two well-marked lateral nerves, by the arrangement of the cystoliths, by longer peduncles, and by the more elongate lobes of the staminate flowers. Since the leaves at a node are not conspicuously unequal, the species should probably be referred to the section containing the long-peduncled pubescent species. The globose staminate heads suggest

P. mollis Wedd., though it is readily distinguished from that species by its shorter, more deeply cut leaves, its shorter peduncles, and the elongate lobes of the staminate flowers.

Pilea obetiaefolia Killip, sp. nov.

Plants monoecious (?), erect, herbaceous, about 30 cm. high; stems glabrous or the younger branches sparingly hirsutulous. Stipules ovate-lanceolate, 8 mm. long, 3 mm. broad, hyaline at margin, copiously covered with fusiform cystoliths on the outer surface. Petioles hirsutulous. Leaf blades oblong-lanceolate, short-acuminate at apex, subcuneate or rounded at base, crenate-serrate (teeth obtuse, 20 to 25 on a side), penninerved, dark green above, yellowish green beneath, bearing fusiform cystoliths on both surfaces; leaves of a pair similar in shape but slightly unequal in size, the larger 7 to 10 cm. long, 2 to 4 cm. wide, with petioles 3 to 4 cm. long, the smaller 5 to 8 cm. long, 2 to 2.5 cm. wide, with petioles 1.5 to 2 cm. long. Pistillate flowers borne in compact cymes 6 to 7 mm. wide on peduncles 5 to 6 mm. long; achenes broadly ovate, 2 mm. long, obtuse.

Type in the U. S. National Herbarium, no. 1,140,924, collected in a moist forest along the Río San Rafael, below Cerro Tatamá, Department of Caldas, Colombia, altitude 2,600 to 2,800 meters, September 7 to 11, 1922, by F. W. Pennell (no. 10374).

The species is characterized by large penninerved leaves similar to those of the genus *Obetia*. Its exact relationship to other species of *Pilea* is difficult to determine. The difference in size of the leaves at a node is not sufficiently great to refer it to the section *Heterophyllae*, while the pubescence of the stem and petioles, though slight, excludes it from the section containing glabrous species. Probably it is best placed in the section *Pubescentes Brevipedunculatae*, where apparently it is the only species with penninerved leaves.

Boehmeria coriacea Killip, sp. nov.

Suffrutescent, 40 to 50 cm. high, dioecious; stems woody toward base, strigose and hispidulous, becoming glabrate. Stipules ovate-lanceolate, 4 to 5 mm. long, acute. Petioles 0.5 to 1.5 cm. long. Leaf blades ovate or elliptic-ovate (the alternate leaves very unequal, the larger 5 to 9 cm. long, 3 to 4 cm. wide, the smaller 1.5 to 2.5 cm. long, 1 to 2 cm. wide), acuminate at apex, cuneate or subrotund at base, 3-nerved (lateral nerves extending to upper third of blade, a secondary pair of nerves reaching to apex), serrate (teeth acutish), thick, coriaceous, strongly rugose-bullate, above silvery gray and glabrous, beneath green, densely appressed-strigose on the nerves and veins and hispidulous. Staminate plants not seen. Pistillate flowers in axillary glomerules 5 to 9 mm. wide; perianth broadly ovoid, 1 mm. long, 0.8 mm. in diameter, sparingly strigillous; style 1.2 mm. long, densely hirsute; achenes orbicular, slightly wing-margined toward apex, acute at both ends.

Type in the U. S. National Herbarium, no. 1,140,931, collected in moist forest along the Río San Rafael, below Cerro Tatamá, Department of Caldas, Colombia, altitude 2,600 to 2,800 meters, September 7 to 11, 1922, by F. W. Pennell (no. 10381).

Boehmeria coriacea is distinguished from its nearest ally, *B. celtidifolia* H. B. K., by its broader leaves with glabrous upper surface and shorter, more nearly globose pistillate flowers. *Boehmeria celtidifolia* is a shrub, while *B. coriacea* is herbaceous.

Boehmeria arbuscula Killip, sp. nov.

Small tree, 3 to 4 meters high, monoecious; young branches angulate, slighty corky, closely appressed-pubescent. Stipules narrowly linear-lanceolate, 3 mm. long. Petioles 2 to 7 mm. long, appressed-pubescent. Leaf blades elliptic-ovate or slightly oblong (the alternate leaves unequal, the larger 1.5 to 3 cm. long, 0.8 to 1.5 cm. wide, the smaller 0.4 to 0.8 cm. long, 0.2 to 0.4 cm. wide), acuminate at apex, cuneate at base, 3-nerved (the lateral nerves extending to the upper third of blade), sharply serrulate, the upper surface dark green, plane or often rugulose, strigillous, with short stiff pellucid hairs, the under surface paler, appressed hirtellous, especially on nerves and veins. Flowers in compact axillary androgynous or unisexual clusters 3 to 4 mm. in diameter. Staminate flowers depressed-globose, 7 mm. wide, strigillous without. Pistillate flowers narrowly lanceolate, about 1.4 mm. long, densely hirsute without; style 0.8 mm. long, hirsute at apex.

Type in the U. S. National Herbarium, no. 1,140,085, collected in thicket near Coconuco, Department of El Cauca Colombia, altitude 2,300 meters, June 17, 1922, by E. P. Killip (no. 6831).

This is probably allied to *B. excelsa* Wedd., a tree known only from Juan Fernández. That species, however, has much larger leaves, hoary white beneath, larger flower clusters, and much longer styles.

Phenax grossecrenatus Killip, sp. nov.

Shrub, 2 to 2.5 meters high; branches sparsely hirsute, at length glabrate. Stipules ovate-lanceolate, 4 to 5 mm. long. Petioles slender, 2 to 5 cm. long, glabrous or sparingly pubescent. Leaves ovate or ovate-lanceolate, 6 to 12 cm. long, 3 to 6 cm. wide, acute at apex, rounded or subcuneate at base, coarsely crenate (teeth 5 to 7 mm. broad, rounded, 10 to 14 on each side), 3-nerved to the upper third of blade, above glabrous except on the tomentulous nerves, beneath minutely pubescent. Flowers in compact axillary androgynous clusters. Staminate flowers few, the lobes 0.5 mm. long. Style 3 to 4 mm. long, minutely pubescent with hooked hairs. Achene ovate, 1 mm. long, sparsely pubescent.

Type in the U. S. National Herbarium, no. 1,140,083, collected at edge of forest, near "Canaan," on the slopes of Mt. Puracé, Department of El Cauca, Colombia, altitude 3,200 meters, June 13, 1922, by F. W. Pennell and E. P. Killip (no. 6680).

Allied to *P. laxiflorus* Wedd., of Peru, this species differs in having larger, longer-petioled leaves, longer stipules, and larger androgynous flower clusters.

SCIENTIFIC NOTES AND NEWS

Dr. T. Wayland Vaughan, geologist of the U. S. Geological Survey, has been appointed Director of the Scripps Institute for Biologic Research of the University of California, and will assume actual charge of the work at La Jolla, California, early in 1924.

J. S. Brown, assistant geologist in the Geological Survey, has accepted a position for one year in the Department of Geology, Missouri School of Mines, Rolla, Missouri.

Dr. L. W. Stephenson, Geologist in Charge of the Section of Coastal Plain Investigation of the Geological Survey, is conducting private stratigraphic work for an oil company in Venezuela. He will be absent from the Survey for six or seven months.

Professor Thompson Brooke Maury died on July 15, 1923, in New York City. He was born in 1838 in Fredericksburg, Virginia. He was well known locally because of his long connection with the Weather Bureau and his association with the late Dr. Cleveland Abbe.

Dr. Raphael Pumpelly, well known geologist, died at Newport, Rhode Island, on August 10, 1923, in his eighty-sixth year. He was born at Owego, New York, in 1837. After being professor of mining geology at Harvard from 1866 to 1875, he was a divisional chief in the U. S. Geological Survey. More recently under the auspices of the Carnegie Institution of Washington Dr. Pumpelly directed a physical, geographical, and archeological exploration of central Asia. He was a member of many scientific societies, including the National Academy of Sciences.

O. F. Cook, Bureau of Plant Industry, and a party of botanists, including William R. Maxon, of the National Museum, recently returned from Central America and the West Indies, where they have been investigating the sources of crude rubber with the purpose of increasing its production in tropical America. Several weeks were spent in Panama, Costa Rica, Nicaragua, and Haiti.

Dr. Karl F. Kellerman, associate chief of the Bureau of Plant Industry, received the degree of Doctor of Science at the commencement of the Kansas State Agricultural College.

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BOTANY.—*New species of plants from Salvador.*[1] Paul C. Standley, U. S. National Museum.

The present paper consists of descriptions of new species of plants of various families, collected in the Republic of El Salvador by Dr. Salvador Calderón, and by the writer in the course of his visit to the country during the winter of 1921–22. The description of a new species of grass has been contributed by Mrs. Agnes Chase, and those of several new Piperaceae and an *Agave* by Dr. William Trelease.

Pennisetum vulcanicum Chase, sp. nov.

Base not seen, plant presumably perennial, probably about 1 meter tall; culms erect or ascending, terete and scabrous below the panicle, otherwise compressed and glabrous, bearing leafy branches from the lower nodes; nodes glabrous; leaves numerous, the sheaths much overlapping, keeled, villous along the margin and on the sides of the collar, otherwise glabrous or very sparsely pilose; ligule a dense ring of hairs about 1 mm. long; blades rather firm, ascending, flat or drying folded, 20 to 45 cm. long, 5 to 8 mm. wide, slightly narrower at base than the summit of the sheath, tapering into an elongate setaceous scabrous tip, scabrous and papillose-pubescent or papillose only on the upper surface, glabrous beneath, the midnerve prominent beneath; panicle slightly flexuous, 10 to 17 cm. long, 18 to 20 mm. wide excluding the longest bristles, tawny or obscurely purple-tinged, rather dense except at the base, the axis strongly angled, pilose on the angles; fascicles on hairy peduncles 1 to 1.5 mm. long, finally spreading or reflexed; bristles numerous, scabrous, united at the very base, very unequal, the outermost short, slender, scabrous only, the inner 1 to 1.5 cm. long, flattened, flexuous, plumose about half their length, the innermost one stouter, 2 to 5 cm. long, plumose at base, unequal in fascicles of the same panicle, the longer in the middle fascicles; spikelets 3 to 5 in each fascicle (only 1 or 2 well developed), sessile, 6 to 9 mm. long, about 1.4 mm. wide, attenuate, scaberulous; glumes attenuate, 3 to 5-nerved, the first $\frac{1}{4}$ to $\frac{1}{3}$, the second $\frac{2}{3}$ to $\frac{3}{4}$, as long as the spikelet; sterile lemma nearly as long as the fertile, finely many-nerved, inclosing a palea of nearly

[1] Published by permission of the Secretary of the Smithsonian Institution.

equal length and a staminate flower; fertile lemma subindurate, 5-nerved, the apex attenuate and spreading.

Type in the U. S. National Herbarium, no. 1,152,018, collected in the crater of the volcano Cerro de la Olla near Chalchuapa, Salvador, in 1922, by Dr. Salvador Calderón (no. 1049).

This species is related to *Pennisetum karwinskyi* Schrad., from the highlands of Mexico, from which it differs chiefly in its larger panicles, in its more numerous bristles, the inner plumose, and in the much longer innermost bristles. A second collection of this species, *Jiménez* 522, from Nuestro Amo, on the Pacific slope of Costa Rica, was referred to *P. karwinskyi* as an exceptional specimen, in a recent revision of the genus.[2] In this specimen the innermost bristles are as much as 5 cm. long, but the inner bristles are much less plumose than in the Salvador specimen. Like that, the plant is without the base.

Lindmania flaccida Standl., sp. nov.

Plants terrestrial; leaves basal, few, very thin and soft, 25–30 cm. long or larger, 3.5–4.5 cm. wide, entire, slightly narrowed near the base, rather abruptly narrowed to a short subulate tip, glabrous above and slightly brown-spotted, beneath very sparsely stellate-lepidote; inflorescence about 50 cm. high, once-branched, the branches long and slender, about 10 cm. long, solitary or fasciculate, sparsely arachnoid-villous or glabrate, the bracts of the scape entire, thin, about equaling the nodes; flowers scarcely secund, nodding, the pedicels slender, about 3 mm. long, glabrous, the bractlets lance-ovate, scarious, much exceeding the pedicels and often equaling the sepals; sepals ovate, acute, about 3 mm. long, scarious, persistent; petals linear-lanceolate, eligulate, 7–8 mm. long, green, acute, conspicuously nerved; stamens shorter than the petals, the anthers linear-oblong, yellow, undulate, not contorted; ovary almost wholly superior, glabrous, the style long and slender, equaling or surpassing the stamens, the branches slender-clavate; seeds numerous, minute, dark brown, with a pale appendage at each end.

Type in the U. S. National Herbarium, no. 1,135,666, collected on a moist shaded bank along a stream in the mountains near Ahuachapán, Salvador, January, 1922, by Paul C. Standley (no. 19786).

The genus *Lindmania* has not been reported previously from Central America, the known species being natives of South America. The present plant may perhaps represent an undescribed genus, but it seems to agree moderately well in most of its characters with the plants heretofore referred to *Lindmania*.

Tillandsia vicentina Standl., sp. nov.

Plants solitary, epiphytic; leaves numerous, about 25–30 cm. long, equaling the inflorescence, thin, 3–5 mm. wide at the middle, the bases 1.5–2 cm. wide, brownish, the blades green on the upper surface and covered with closely appressed scales, beneath silvery, covered with coarse loose whitish scales; scapes 15–25 cm. high, stout, covered with numerous overlapping bracts, these coarsely lepidote, their tips filiform-attenuate, their bases slightly inflated; spikes 5–11, simple, digitate or shortly pinnate, sessile, 4–7 cm. long,

[2] Chase, Contr. U. S. Nat. Herb. **22**: 220. 1921.

their bracts compressed, 2–2.5 cm. long, pink, thin, loosely appressed and overlapping for half their length, coarsely and loosely lepidote; sepals distinct, 2 cm. long, glabrous; corolla violet, exceeding the bracts 2–2.5 cm.; stamens conspicuously exceeding the corolla, the style long-exserted.

Type in the U. S. National Herbarium, no. 1,137,360, collected on the Volcán de San Vicente, Salvador, altitude about 1500 meters, March 8, 1922, by Paul C. Standley (no. 21588). *Standley* 21588 from the same locality represents the same species.

Related to *T. digitata* Mez and *T. flabellata* Baker, but readily distinguished by the coarse, loose pubescence of the leaves and bracts. The pubescence is similar to that of *T. streptophylla* Scheidw., but less coarse, and the leaves are not dilated at the base as in that species.

Dioscorea salvadorensis Standl., sp. nov.

Stems scandent, slender, very minutely and sparsely hirtellous or glabrate, with elongate internodes; petioles mostly 2.5–3.5 cm. long, pubescent like the stems; leaf blades about 9 cm. wide and 7–9 cm. long, cordate at base, with a broad rounded sinus, 3-lobed to the middle or nearly to the base, the lateral lobes somewhat falcate, obtuse to acuminate, the terminal lobe obtuse to acuminate and cuspidate-mucronate, glabrous on the upper surface, beneath minutely muricate-hirtellous along the nerves; staminate spikes solitary, long-pedunculate, simple, 15–22 cm. long or longer, the rachis glabrous, slender, the flowers sessile; bractlets lance-attenuate, shorter than the flowers; perianth segments narrowly oblong, obtuse, 2 mm. long, glabrous; stamens 3, two-thirds as long as the perianth segments, the anthers oblong, the filaments broad, slightly dilated toward the base, nearly equaling the anthers.

Type in the U. S. National Herbarium, no. 1,151,507, collected on the Cerro de la Olla, on the Guatemalan frontier, near Chalchuapa, Salvador, in 1922, by Dr. Salvador Calderón (no. 1020). Also collected at La Cebadilla, Departamento de San Salvador in 1922, *Calderón* 1238.

Among the Central American species of *Dioscorea* this is easily recognized by its trilobate leaves.

Agave calderoni Trelease, sp. nov.

Of the group *Guatemalenses.* Acaulescent, not cespitose (?). Leaves green or very lightly and evanescently glaucescent, oblanceolate-oblong, acute, smooth, about 15 cm. wide and 80 cm. long; spine brown or somewhat tinged with purple at base, slightly glossy, elongate-conical or subacicular, straight, slightly flattened above and involutely grooved with acute edges below the middle, narrowly decurrent for about twice its own length, intruded into the green tissue dorsally, about 40 mm. long and 5 mm. thick; teeth chestnut-colored, 5–10 mm. apart, frm, but small (scarcely 1 mm. long), triangular, lenticularly widened into the nearly straight margin. Inflorescence paniculate, apparently with rather short branches and closely bunched flowers, the rather thick and short (5 mm.) pedicels densely invested by short broad papery bracts. Flowers bright orange, about 40 mm. long; ovary 15–20 mm. long, about equaling the perianth, oblong; tube broadly conical, scarcely 5 mm. deep; segments 10–15 mm. long, shorter than the ovary; filaments inserted nearly in the throat, about 40 mm. long. Capsules unknown; not known to be bulbiferous.

Type in the U. S. National Herbarium, no. 1,152,451, taken from a plant cultivated in San Salvador, Salvador, January, 1923, by Dr. Salvador Calderón (no. 1463).

The vernacular name is *magueyón*.

Peperomia izalcoana Trelease, sp. nov.

A glabrous subrhizomatous herb; stem slender (2 mm.), scarcely 30 cm. high; leaves alternate, round- or subdeltoid-ovate, blunt or subacute, round-based, moderate or rather small (2–4.5 cm. long), 5 or 7-nerved; petiole rather short (scarcely 3 cm.); spikes terminal and opposite the leaves, 40–100 mm. long, loosely flowered; peduncle, depending on the spike length, 1–3 cm. long; bracts round-peltate; berries ellipsoid, essentially sessile; style short but evident; stigma apical.

Type in the herbarium of the University of Illinois, collected at Izalco, Salvador, on wet bank, March 19, 1922, by Paul C. Standley (no. 21874).

Peperomia matapalo Trelease, sp. nov.

A villous assurgent herb; leaves alternate or the uppermost congested into a whorl of 2 or 3, elliptic-oblanceolate or the lower reduced and obovate, rather small (1.5–2 cm. wide, 3–4.5 cm. long), obtuse or bluntly acuminate, cuneate, 5-nerved, appressed-villous on both faces; petiole short (5 mm.); spikes terminal, 2 mm. thick, 50–70 mm. long, rather closely flowered; peduncle 10–15 mm. long; bracts round-peltate; ovary subglobose; stigma obliquely anterior.

Type in the herbarium of the University of Illinois, collected at San Salvador, Salvador by Dr. Salvador Calderón (no. 1121).

The common name is *matapalo*.

Peperomia standleyi Trelease, sp. nov.

A delicate fleshy glabrous herb, creeping over tree branches; stem filiform; leaves commonly 4–6 at a node, elliptic-obovate, acute-based, minute (5–7 mm. wide, 8–10 mm. long), 1 or obscurely 3-nerved, impressed-punctulate; petiole 2–3 mm. long; spikes terminal, scarcely 2 mm. thick and 15 mm. long, rather loosely flowered; peduncle about 10 mm. long; bracts round-peltate; ovary ovoid, submucronulate; stigma apical.

Type in the herbarium of the University of Illinois, collected at Tonacatepeque, Departamento de San Salvador, Salvador, December 30, 1921 by Paul C. Standley (no. 19426).

Piper patulum cordifolium Trelease, var. nov.

A shrub 2–3 m. tall, glabrous except that the leaves are more or less puberulent on the nerves beneath; leaves broadly ovate, acuminate, deeply cordate with rather narrow sinus, moderately large (10–16 cm. wide, 15–23 cm. long); spikes in fruit 4 mm. thick and 130 mm. long; berries oblong-truncate, glabrous.

Type in the herbarium of the University of Illinois, collected at Nahulingo, Departamento de Sonsonate, Salvador, March 21, 1922, by Paul C. Standley (no. 22046).

Piper standleyi Trelease, sp. nov.

A shrub 1–1.5 m. tall; twigs slender, for a time conspicuously subhirsute; leaves membranous, lance-oblong, long-acuminate, inequilaterally cordulate, rather small (1.5–2.5 cm. wide, 5–9 cm. long), subpalmately 5-nerved, hirsute

beneath on the nerves; petioles short (2–4 mm.), not winged, hirsute; inflorescence unknown.

Type in the herbarium of the University of Illinois, collected on the Volcán de San Salvador, Salvador, in moist forest, altitude about 1800 meters, April 7, 1922, by Paul C. Standley (no. 22894).

Piper uncatum Trelease, sp. nov.

A practically glabrous shrub with the general characters of *P. marginatum* but the subciliate leaves concavely truncate at base and with the margins subconfluent across the petiole, and with rather slender spikes 2–3 mm. thick and 150 mm. long, abruptly hooked below the middle.

Type in the herbarium of the University of Illinois, collected at Tonacatepeque, Departamento de San Salvador, Salvador, December 30, 1921, by Paul C. Standley (no. 19435).

Piper uncatum levyanum Trelease, var. nov.

Differing from the type in having the upper surface of the leaves and the veins beneath more or less persistently hairy.

Type in the Copenhagen Herbarium, collected at Granada, Nicaragua by Lévy (no. 1294). *Baker* 850 from the same locality also represents the same variety.

Ficus rensoniana Calderón & Standl., sp. nov.

Young branchlets brownish, densely fulvous-pilose; stipules ovate-oblong, 1.5–2 cm. long, acute or acuminate, rather tardily deciduous, thin, brown, densely pilose outside below the middle; petioles stout, 1–2.5 cm. long, densely pilose; leaf blades oval or oblong-oval, broadest at or near the middle, 7–10.5 cm. long, 4–6 cm. wide, cordate at base, rounded or very obtuse at apex, coriaceous, short-pilose above, especially along the nerves, copiously short-pilose beneath with white hairs, the lateral nerves prominent, 6 or 7 pairs, arcuate-ascending, distant, anastomosing near the margin; peduncles geminate, stout, 4–6 mm. long; involucre bilobate, 10–12 mm. long, the lobes rounded, thin, brown, strigose near the base, glabrous within; receptacles globose, 8–11 mm. in diameter, glabrous, the ostiole prominent, closed by 3 rounded scales.

Type in the U. S. National Herbarium, no. 1,152,090, collected at San Salvador, Salvador, August, 1920, by Dr. Salvador Calderón (no. 1120).

Most closely related, apparently, to *F. pringlei* S. Wats., which is distinguished from the Salvadorean tree by its dense pubescence, larger receptacles, and sericeous involucres.

Aristolochia salvadorensis Standl., sp. nov.

A large woody vine, the branches densely brownish-puberulent, with very short internodes; petioles stout, densely puberulent, 5–7 mm. long; leaf blades oblong, often slightly wider above the middle, 11–20 cm. long, 4–9 cm. wide, acute or abruptly short-acuminate, rounded at base, thick, glabrous above, with prominulous venation, beneath lustrous, puberulent along the nerves, 5-nerved from the base and with several pairs of lateral nerves, the veins very prominent and reticulate; racemes large, branched, borne at the base of the stem, the rachis densely brown-pilose with short hairs, often geniculate, the bracts ovate or lanceolate, 12 mm. long or less, sometimes green and foliaceous, the pedicels mostly 5–7 cm. long, slender; bractlets none

at base of calyx; ovary about 1.5 cm. long, abruptly curved near the base, 6-costate, densely brown-pilose; calyx dark brown-purple, about 4.5 cm. long, sparsely puberulent outside, the tube very short and inflated, the pouch inflated, rounded, produced within the limb into a large blunt recurved beak, the limb shallowly 3-lobed, the 2 lateral lobes broad, acute, the central lobe much smaller and narrower, acute or short-acuminate; style short, the stigma obscurely lobate; capsule oblong, about 7 cm. long and 2–2.5 cm. in diameter, sharply 6-angulate, brown-tomentulose.

Type in the U. S. National Herbarium, no. 1,111,203, collected at San Salvador, February 9, 1923, by Dr. Salvador Calderón (no. 1484). The following additional specimens have been examined:

SALVADOR: San Salvador, November, 1921, *Calderón* 287. Santa Tecla, August, 1922, *Calderón* 1096. Sierra de Apaneca, region of the Finca Colima, Departamento de Ahuachapán, January, 1922, *Standley* 20036.

The vernacular names are *guaco, guaquito,* and *guaquito de la tierra.* Like other species of the genus, it is employed locally as a remedy for snake bites.

Aristolochia salvadorensis is related to *A. arborea* Linden, but has very different flowers and much smaller, reticulately veined leaves. The leaves somewhat resemble those of *A. maxima* L., which also is abundant in Salvador, but the flowers of the two species are quite dissimilar, and even sterile specimens of the two are easily distinguishable.

Coccoloba montana Standl., sp. nov.

Young branchlets terete, pale, glabrous; ocreae brown, glabrous, 6–7 mm. long; petioles stout, glabrous, 12–20 mm. long; leaf blades ovate or oblong-ovate, 10–20 cm. long, 5.5–10 cm. wide, acuminate or long-acuminate, unequal at base, rounded on one side, on the other semicordate, glabrous above, glabrous beneath except along the costa, there brownish-tomentose, especially in the axils of the lateral nerves, papyraceous, the costa salient on both surfaces, the venation conspicuous above and beneath and closely reticulate.

Type in the U.S. National Herbarium, no. 1,135,924, collected in the Sierra de Apaneca, region of the Finca Colima, Departamento de Ahuachapán, Salvador, January, 1922, by Paul C. Standley (no. 20061).

The vernacular name is *papaturro.* Although known only from sterile specimens, the leaves of this *Coccoloba* are so distinct from those of the other Central American species that it seems desirable to give it a name for purposes of reference.

Pleuropetalum calospermum Standl., sp. nov.

Slender shrub, 1–2 m. high, the young branches granular-papillose; petioles slender, 1–3 cm. long; leaf blades oblong-ovate to lance-oblong, 9–13 cm. long, 3–5 cm. wide, long-acuminate, rounded or obtuse at base and abruptly decurrent upon the petiole, thin, bright green above, paler beneath, when young obscurely puberulent but quickly glabrate; inflorescences terminal and in the upper axils, cymose-paniculate, few-flowered, long-pedunculate, shorter than the leaves; pedicels very stout, sometimes 7 mm. long but usually much shorter; bractlets rounded-ovate, 1 mm. long; sepals rounded-oval, 3–3.5 mm. long, rounded at apex, sharply ribbed, glabrous; fruit baccate, black, 6–7 mm. broad, globose, glabrous; seeds numerous, on thickened

funicles, nearly 2 mm. in diameter, black, lustrous, with a metallic and iridescent sheen.

Type in the U. S. National Herbarium, no. 1,135,662, collected in a moist wooded ravine in the mountains near Ahuachapán, Salvador, altitude about 1000 meters, January, 1922, by Paul C. Standley (no. 19782). Also collected in the region of Finca Colima, Sierra de Apaneca, Departamento de Ahuachapán, *Standley* 20074.

Two other species of *Pleuropetalum* are known from Central America, *P. sprucei* (Hook. f.) Standl., which ranges from Veracruz to Ecuador, and **P. pleiogynum** (Kuntze) Standl. (*Celosia pleiogyna* Kuntze, Rev. Gen. Pl. 541. 1891). In the North American Flora[3] the latter was referred to the genus *Celosia*, but further study of the material indicates that it is really a species of *Pleuropetalum*.

Pleuropetalum calospermum has sepals of about the same size as those of *P. pleiogynum*, but in the latter the seeds are half as large, much more numerous, and on slender funicles. From *P. sprucei* the Salvadorean plant is distinguished by its much larger sepals and capsules.

ENTOMOLOGY.—*Three new Pemphredonine wasps* (*Hymenoptera*). S. A. Rohwer, Bureau of Entomology.

Two of the species described below have been recently received from correspondents who are anxious to use the specific name in connection with some observations on habits of the species.

Microstigmus guianensis, new species.

This species seems to be very close to *M. theridii* Ducke, which has been recorded from French Guiana by Buysson,[1] but it does not agree with the description in all ways, especially in the sculpture of the mesoscutum.

Female.—Length 2.5 mm. Clypeus gently convex, the anterior margin broadly and gradually rounded; interocular quadrangle somewhat higher than broad; head shining, polished; the ocelli in an acute triangle; flagellum slightly thickening apically, the first joint distinctly longer than the second, which is slightly longer than the third; dorsal surface of the pronotum polished, the anterior margin with a sharp carina; mesoscutum coarsely reticulate, the posterior margin with a transverse carina; the scutellum with four strong carinae which meet medianly and form a transverse pyramid, the posterior face of which has a triangular shaped area bounded by striae; posterior margin of the scutellum with a strong, high carina; dorsal area of the propodeum irregularly reticulate on a granular surface, the margin bounded by a U-shaped carina; mesepisternum granular and with a few irregular raised lines; sides of the propodeum with a few oblique striae; posterior face of the propodeum with coarse reticulations; petiole short, carinate laterally; abdomen polished; stigma oval, its greatest width slightly longer than the first abscissa of the radius. Head rufo-ferrugineous; clypeus, mandibles and lower part of face stramineous; thorax, legs and petiole stramineous; the top of the scutellar

[3] **21**:98. 1917.

[1] Ann. Soc. Ent. France, **76**: 29. 1907.

tubercle and the posterior scutellar ridge piceous; (the scutum has two oval brownish spots, but inasmuch as these are asymmetrical it is probable that they are due to discoloration); apical part of the abomen ferrugineous; wings hyaline, iridescent, with a slight yellowish tinge; venation fulvous, except black stigma.

Type-locality—Kartabo, Bartica District, British Columbia.

Described from a single female collected by P. G. Howes, 1922, and given his number 16622. This specimen is collected with its nest. The nest in general outline agrees very well with Ducke's figure of the nest of *M. theridii*.[2]

Type.—Cat No. 26480 U.S.N.M.

Microstigmus brunniventris, new species.

The dark abdomen readily distinguishes this species from the other known forms.

Female.—Length 2.25 mm. Clypeus convex, the anterior margin with a broad, gentle emargination; interocular quadrangle broader than high; the lower part of frons finely granular, the rest of the head polished; flagellum only slightly thickening apically, short, first joint slightly shorter than the second; ocelli in an equilateral triangle; dorsal surface of pronotum polished, the anterior margin with a sharp carina; scutum rather coarsely granular and in some lights with a tendency to become feebly rugose; scutellum pyramidal but, when seen from the top, with lozenge-shaped area; posterior margin with a low ridge; dorsal surface of the propodeum U-shaped with two median longitudinal ridges on a feebly reticulate surface; posterior face of the propodeum coarsely reticulate, the reticulations in three series so that at some angles there appear to be three transverse ridges; mesepisternum reticulate; sides of the propodeum granular and with large, poorly defined reticulations; petiole longer than the hind coxa, with two carinae which become approximate medianly; abdomen highly polished; stigma triangular, its greatest width distinctly greater than the first abscissa of the radius. Ferrugineous; apices of the antennae, dorsal aspect of the propodeum piceous; abdomen, including petiole, very dark brown; legs testaceous; wings hyaline, iridescent; venation testaceous, except a dark brown stigma.

Type-locality.—San Bernardino, Paraguay.

Described from a single female collected May 19th by K. Fiebrig.

Type.—Cat No. 26481 U. S. N. M.

Stigmus fulvicornis, new species.

This species seems to be closest to *S. conestogorum* Rohwer, but it is smaller, the intermediate legs are pale, and the sides of the pronotum are without a dentation.

Female.—Length 3 mm. Head, when seen from above, subquadrate, though slightly narrowing posteriorly; anterior margin of the clypeus bilobed; front very finely granular, rest of the head smooth and polished; antenna simple, the third joint subequal with the fourth; dorsal surface of the pronotum rather coarsely rugoso-granular, the transverse carina rather feeble and subdentate laterally; sides of the pronotum not dentate; mesoscutum polished, under high magnification feebly reticulate anteriorly and with the usual impressed

[2] Ann. Soc. Ent. France, 76: 29. 1907.

longitudinal lines, under high magnification the posterior portion is lineolate; suture between the scutum and the scutellum foveolate; scutellum flat, the surface finely reticulato-granular; the metanotum sculptured like the scutellum; dorsal aspect of the propodeum with a median longitudinal ridge and with three U-shaped ridges, the surface between these with large irregular reticulations; mesepisternum granular above, shining below; sides of the propodeum obliquely striate with a tendency to become reticulate dorsally; petiole with two longitudinal carinae which approximate each other posteriorly; the area between the carinae anteriorly with transverse rugae; the area laterad of the carinae with oblique ridges; abdomen highly polished; pygidium sharply defined, two times as long as the basal width; second and third abscissae of the cubitus subequal. Black; antennae, four anterior legs, posterior trochanters, bases of the posterior tibiae and the posterior tarsi ferrugineous; tubercles white; tegulae testaceous; wings hyaline, iridescent; venation, including the stigma, pale brown.

Type-locality.—Starkville, Mississippi.

Described from four females (one type) received from M. R. Smith, who states that the species was nesting in holes in a floor of a piazza, and that the nests were provisioned with aphids.

Type and *paratype.*—Cat No. 26479, U. S. N. M. Paratypes returned to the collection of the Agricultural College of Mississippi.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY

652D MEETING

The 652d meeting of the Biological Society was held in the lecture room of the Cosmos Club March 31, 1923, at 8.05 p.m., with President HITCHCOCK in the chair and 112 persons present. HOMER C. SKEELS was elected to membership.

Under *Short Notes*, Dr. R. W. SHUFELDT exhibited a large bullfrog captured in Alexandria a few days before, which when properly excited, squalled very much like a toy balloon or a cat in distress.

Miss P. L. BOONE reported a newly discovered fossil deposit near Weems, Virginia, containing isopods and a skeleton which may be that of a crocodile.

S. F. BLAKE reported the observation of a belled turkey buzzard in Washington in October 1922. Similar cases were mentioned by P. BARTSCH and F. A. McCLURE.

The regular program was as follows: C. A. REED: *Biological observations in China* (lantern). The speaker described his itinerary on a recent trip in China, and gave an account of the methods of agriculture of the Chinese, illustrating his talk with numerous lantern slides. The paper was discussed by Messrs. McCLURE, HOWARD, STILES, SHUFELDT, HITCHCOCK, and PIPER. (No abstract received.)

C. W. STILES: *Brother Bryan's revolution against evolution.* According to Mr. Bryan's premises, all germs which cause disease must have been created in the beginning as they exist today. If it is to be conceded that these germs were originally created in some form other than as disease germs, the theory of evolution stands admitted. Obviously, since Adam was the last animal created and since the animals were not created until after the plants, it is unthinkable that any of the numerous germs which cause disease were created after Adam. Since disease germs are dependent for their existence upon animals and plants in which they cause disease, it is clear that these germs could not have been created or have existed prior to the creation of their victims. A challenge of this deduction would be an admission that the germs were not created as they are to-day, but that they later evolved into disease germs; but this would be an admission of evolution. Therefore, if Mr. Bryan's challenge is to be accepted, we must conclude that Adam harbored every germ disease which is characteristic of man or dependent on man for its life cycle, and that, further, the Garden of Eden may have been in China, because that is the only place where man is known to survive some of the afflictions. (*Author's abstract.*)

653D MEETING

The 653d meeting of the Biological Society was held in the lecture room of the Cosmos Club April 14, 1923, at 8.05 p.m., with President HITCHCOCK in the chair and 69 persons present. Owing to the length of the program, the usual *Short Notes* were passed over. The regular program was as follows:

Mrs. CHARLES D. WALCOTT: *Wild flowers of the Canadian Rockies* (lantern). The speaker exhibited a large number of beautifully colored slides of the wild flowers and scenery of the Canadian Rockies and the Selkirks, particularly from the vicinity of Lake Louise and the Yoho Valley. The paper was discussed by T. ULKE, P. BARTSCH, and C. D. WALCOTT.

A. B. MANN: *The usefulness of diatoms* (lantern). The value of diatoms as a source of polishing powders, in the manufacture of dynamite (formerly) and filters, as a source of petroleum, and as the basic food of practically all sea animals, was described. The geographical distribution of diatoms is very definite, and their occurrence in the ocean and in the air promises to be of great importance in the future in the study of aerial and oceanic currents. They will also come to be of great significance in the discovery of new petroleum areas, supplementing the Foraminifera, the group now used for this purpose. The shapes and pattern of ornamentation of the different forms offer a valuable field for those interested in the development of new patterns to be used in decorating and in the mechanical arts. In conclusion, the speaker showed a number of slides illustrating a few of the 8000 known species.

654TH MEETING

The 654th meeting of the Biological Society was held in the lecture room of the Cosmos Club April 28, 1923, at 8 p.m., with President HITCHCOCK in the chair and 38 persons present. CARLYLE CARR, K. McL. SMOOT, and PERCY VIOSCA, JR., were elected members of the Society.

Under *Short Notes*, Dr. A. D. HOPKINS stated, with reference to the belled turkey buzzards reported at a previous meeting, that he is informed that ELI HAMRICK, a mountaineer of Webster Springs, West Virginia, has for some years been in the habit of attaching bells to turkey buzzards. This probably explains the occurrence of such birds in this region.

AGNES CHASE: *Hunting types of plants in European herbaria* (lantern). The speaker visited European herbaria last year in quest of types of grasses. The important Hackel herbarium is deposited in the Naturhistorisches Museum of Vienna, making this probably the finest grass collection in Europe. Permission was given to take spikelets for the U. S. National Herbarium and many duplicates of classic collections were obtained. A brief visit was made to Professor HACKEL at Attersee. Munich, Florence, and Pisa were visited. An important collection of grasses made by Raddi in Brazil in 1817–1819, and preserved at Pisa, is the basis of a small and rare work on the grasses of Brazil. The Delessert herbarium at Geneva, the Berlin herbarium, the Rijks Herbarium at Leiden, the Botanical Garden at Brussels, the Paris Herbarium, and the Kew Herbarium and British Museum in London, were visited. The paper was discussed by Messrs. OBERHOLSER and PALMER.

S. PRENTISS BALDWIN; *Bird banding—a new method of bird study* (lantern). Most of the speaker's work in bird banding has been done at Thomasville, Ga., and Gates Mills, near Cleveland, Ohio. The methods of attaching bands to birds legs and the different types of traps used were illustrated by numerous colored lantern slides. The breeding records of a number of House Wrens were shown on the screen, and attention was called to the fact that after raising the first brood of the year, the pair almost invariably separate and take different mates for the second brood. The use of the bird banding method is of great value in indicating the extent to which individual birds return to the same locality to nest, and also in its application to the study of wintering birds and of migrants. Very frequent visits are made to the traps, and as the birds appear to appreciate the supply of food found in these, it frequently happens that the same individual enters a trap several times a day. It has been found that individual Chipping Sparrows not only remain in a closely restricted locality during a whole winter, but also return to the same winter quarters in succeeding years. A large proportion of the specimens of this species are found to be afflicted

with diseases of the feet, causing malformations and the loss of claws. This paper was discussed by Dr. H. C. OBERHOLSER.

655TH MEETING

The 655th meeting was held May 12, 1923, at 8 p.m., in the lecture room of the Cosmos Club, with President HITCHCOCK in the chair and 52 persons present.

Under *Short Notes*, Dr. R. W. SHUFELDT exhibited lantern slides of the fine gorilla recently mounted at the National Museum.

E. T. WHERRY: *Studies of plant distribution in relation to soil acidity.* The speaker reviewed his method of testing soil acidity, as published in Smithsonian Report for 1920, Gen. App. pp. 247–268, showing colored lantern slides of numerous species of native plants; he discussed the results of acidity tests of their soils, and the probable bearing of these on peculiarities of their distribution.

E. A. GOLDMAN: *The deer of the Grand Canyon National Game Preserve.* Peculiar conditions were described under which mule deer have become excessively abundant, and are still rapidly increasing in numbers. They are estimated to number at least 20,000. The deer are in excellent condition, but forage available in summer is taken to near the limit of production. Closer utilization of forage in summer will result in the serious impairment of carrying capacity of range. It is therefore foreseen that unless the increase in number of deer is controlled the starvation of some of the animals must result in he near future.

S. F. BLAKE, *Recording Secretary.*

ENTOMOLOGICAL SOCIETY

357TH MEETING

The 357th meeting of the Society was held April 5, 1923, at the New National Museum, with President HOWARD in the chair and 35 persons present. J. M. C. GARDNER and C. P. LOUNSBURY were elected members of the Society.

The regular program was as follows: PEREZ SIMMONS: *A house-fly plague in the American Expeditionary Forces.* The house-fly became a serious danger to health during the summer of 1918 at one of the camps of the 20th Engineers (Forestry) at Lamanchs, Department of the Landes, southwestern France. A location that should have been unusually healthful was transformed into a place of pestilence through neglect of sanitation. A severe epidemic of dysentery was followed by influenza and pneumonia, and there is strong evidence to support the belief that the fly-borne dysentery was largely responsible for the severity of the influenza among the main body of troops at Lamanchs. Although commissioned entomologists would have encountered substantial difficulties, it is felt that a great deal of good would have been accomplished by qualified men applying preventive and remedial measures at the proper time. (*Author's Abstract.*)

Doctor HOWARD said this paper gave a striking picture of conditions in camp. Orders were given, but they were not always carried out; but there was a cause for not enforcing them. Doctor Howard made suggestions to the Army officials and it was obvious that they were needed. The Army officials said they did not want men trained to count the spots on flies and mosquitoes, but they did want trained, sanitary engineers.

C. C. HAMILTON: *Biology of tiger beetles.* (Illustrated by charts.) This paper will be ready for publication shortly as an extended article treating of the morphology, classification, and biology of the known tiger-beetle larvae of America and Europe. The biological information has been derived principally from Shelford's and Griddle's published works and Shelford's unpublished notes. Very little is known regarding the habits of this interesting group other than those of the genus *Cicindela.* The part on classification deals with the genera *Cicindela, Tetracha, Omus,* and *Amblychila,* all occurring in the United States, and the genera *Cicindela* and *Tetracha* from Europe, the genus *Collyris* from the West Indies, and the genus *Ctenostema* from Central America. In all, the larvae of about fifty different species were studied. The larvae have good morphological characters for separating the genera, and most of the specific characters are definite. (*Author's abstract.*)

DR. CLEVELAND, of The Johns Hopkins University: *Intestinal protozoa of termites from a physiological standpoint.* He spoke of the wood-feeding termites and their intestinal protozoa with regard to the relation of the protozoa to the host. By incubation the protozoa were separated from the termite hosts. Some of the termites were much more difficult to keep alive than others. It was thought that the cause for some dying so easily was due to removing the protozoa. By replacing the protozoa the termites did not die as rapidly but lived over three or four months, while those from which the protozoa had been removed died in ten to twenty days.

MR. HYSLOP: *The Coleopterous family, Plastoceridae.* (Illustrated.) This family, erected by Otto Schwarz (1906) to include the genera referred to by Candeze (1863) in his Elaterid tribe, Campylides, was found to contain a heterogeneous group of genera, so that it is inadvisable to consider further this family as valid. The type genus *Octonodes* Candeze (*Plastocerus* Lec. not Schaum) is based upon insects which recent larval studies have shown to be typical Cebrionids, while the genus *Lepturoides* Hbst. (*Campylus Fitch.*) is a typical Elaterid, closely related to the genus *Athous.* The genus *Oestodes* Lec., also included in this family, is of very doubtful position. The many exotic genera in the family present characters in the adults that make it difficult to consider them associated as a well defined family, and further larval studies will, undoubtedly, place many of them in other well recognized families. The specimens which led to this discussion were collected by W. B. Turner of the Office of Cereal and Forage Insect Investigations' Field Laboratory at Sacramento, California.

CHAS. T. GREENE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

A cablegram received from Kuling, Kiangsi Province, China, states that CHARLES M. HOY died from appendicitis on September 8. Mr. Hoy had been in China since the first of the year, collecting mammals for the National Museum. From the time of his arrival he had experienced innumerable hardships, due to heavy rains, intense heat, stinging caterpillars, and accidentally shooting himself in the leg last July.

Letters recently received from Dr. A. S. HITCHCOCK, of the Department of Agriculture, report that good progress is being made in collecting botanical specimens in Ecuador. In the first part of August ten days were spent in the vicinity of Tulcán, much collecting being done on the high paramos.

Later, Mt. Pinchincha was ascended. Dr. Hitchock was planning to spend the greater part of September in the region about Loja, Cuenca, and Huigra.

G. F. Loughlin has been made Acting Chief of the Section of Metalliferous Deposits, Division of Geology in the U. S. Geological Survey.

On the afternoon of September 20, a violent explosion followed by fire occurred in the Dynamometer Laboratory of the Bureau of Standards. One man was killed instantly, three others injured so seriously that they died during the night, and four others seriously burned or cut. The heroism of the survivors of the staff in rescuing the injured from the furiously burning wreckage and in shutting off the electric circuits and the ammonia valves, minimized the loss of life and property.

The explosion occurred in the altitude chamber which is used in testing the performance of aircraft engines under the conditions of low pressure and temperature obtaining at high altitudes. At the time of the accident the room was being used in investigating the performance of an automobile engine, at temperatures corresponding to winter operation, using various grades of gasoline. The work was intended to determine the possible increase in gasoline production per barrel of crude oil, with the accompanying conservation of our national resources, by the use of gasoline of lower volatility.

The explosion was due to the ignition of an explosive mixture in the chamber.

The dead are: Logan L. Lauer, Urban J. Cook, Stephen N. Lee, Joseph Kendig. The injured are: Henry K. Cummings, Frank E. Richardson, Roger Birdsell, George W. Elliott, C. N. Smith, R. F. Kohr.

Most of these men were college graduates with experience and skill in research work, and a grave blow to science and engineering must be added to the human loss to their families and colleagues.

Thus grows the long list of those who have given their lives for the increase of human knowledge and welfare.

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ANTHROPOLOGY.—*Stone adzes of Egypt and Hawaii.* HENRY S. WASHINGTON, Geophysical Laboratory.

Similarity or identity in form, design, or other characters of various objects, such as tools or weapons, made by primitive peoples who inhabit widely separated parts of the earth, is a matter of considerable interest in anthropology. These correspondences may be wholly independent of each other, because the human mind works much the same, especially as regards primitive needs, whatever may be the ethnic stock, so that similar circumstances or needs may give rise to similar solutions of the problem. Thus, closely similar tools or weapons may be developed among the most diverse and widely separated peoples, between whom no communication may be reasonably postulated. On the other hand, it has frequently happened that, in the course of trade or other inter-communication, one people has borrowed ideas from another, so that cases of resemblance in artifacts may be indicative of such contacts in the past. The bearing of these considerations on problems of ethnic origins or migrations is obvious.

In the present note attention is called to a somewhat striking case of similarity in rather primitive tools—adzes—used by two very different peoples, widely separated both in space and time. The correspondence would seem to have been overlooked, but if it has already been noted its republication will do no harm, and the illustrations of the objects, at least, may be of service to anthropologists. For the photographs I am indebted to Mr. J. Harper Snapp of the Geophysical Laboratory.

The Egyptian adze, shown in Figs. 1–3, is one of several that I picked up in December, 1889, on the talus slope below the tombs at Beni Hassan, on the east bank of the Nile, about 167 miles south

of Cairo. These tomb chambers, which date from the XIIth dynasty, about 2500 B. C., were hewn in a stratum of Middle Eocene (Moqattam) limestone which here forms the cliffs that border the Nile valley on the east.[1] The adzes, of which many could be found thirty-five years ago on the talus slope, were used for the excavation of the chambers according to Seton Karr,[2] although Petrie[3] states that they were used "for dressing down the walls of the rock chambers." Similar, but rougher, adzes were used at the XIIth and XVIIIth dynasty tombs at Qurneh, near the Tombs of the Kings at Thebes, and are figured by Petrie.[4] One of the adzes that I collected was given to the U. S. National Museum and another to the Metropolitan Museum of Art in New York City.

The adze figured here is 21 cm. long, 8 cm. in greatest width, and 6 cm. in greatest thickness. The proximal end is broken and the original length was probably 4 or 5 centimeters more than the present. The adze weighs 1338 grams.

The material is a dense, very fine-grained, cream-colored, siliceous limestone, which is barely scratched by quartz and is therefore much harder than the limestone in which the tomb chambers were hewn. It is possible that the material came from the vicinity of the tombs, but the secondary silica present indicates that it may come from the Gebel Ahmar sandstone between Cairo and Suez.

Study of a thin section under the microscope shows that the rock contains much silica, which is apparently of secondary origin, interstitial between the minute indefinite particles of calcite, with some grains of quartz sand. Foraminifera are rather abundant, which were determined by Dr. T. W. Vaughan as nummulites and other unidentified genera. These fossils are not silicified, but it was not ascertained whether they are composed of calcite or aragonite. The rock effervesces vigorously with hydrochloric acid, leaving a large residue of white silica which retains the form of the rock particles. An incomplete chemical analysis gave me the following results: SiO_2 50.75, $Al_2O_3 + Fe_2O_3$ 2.63, CaO 25.28, MgO 0.06, CO_2 (calculated) 19.92, Sum 98.64. The rock is therefore composed of silica and calcium carbonate in about equal parts. Petrie calls the material of these Beni Hassan adzes "sandstone," and Karr speaks of those

[1] For a description of this formation see REED, F. R. C., *The geology of the British Empire*, 37, London, 1921.

[2] Cf. BUDGE, E. A. W., *The Nile*, 645, London, 1907.

[3] PETRIE, W. M. FLINDERS, *Tools and weapons*, 46, *pl. 53*, nos. 82–85, London, 1917.

[4] PETRIE, *Qurneh*, *pl. 9*, London, 1909.

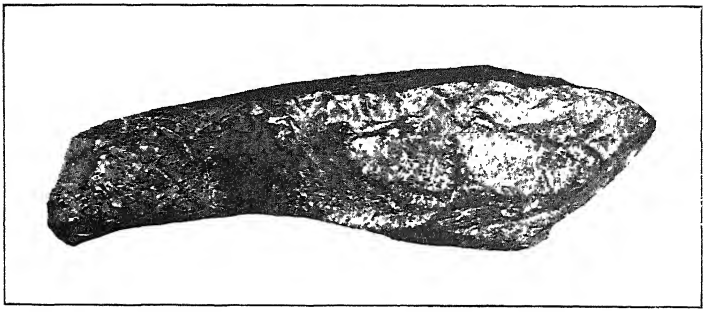

Fig. 1

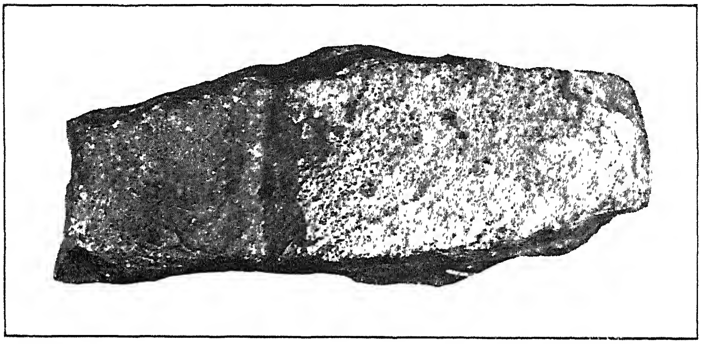

Fig. 2

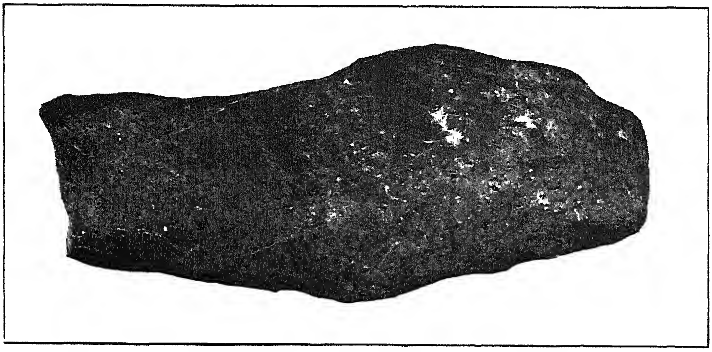

Fig. 3

Egyptian adze: fig. 1, side view, fig. 2, top view; fig. 3, bottom view

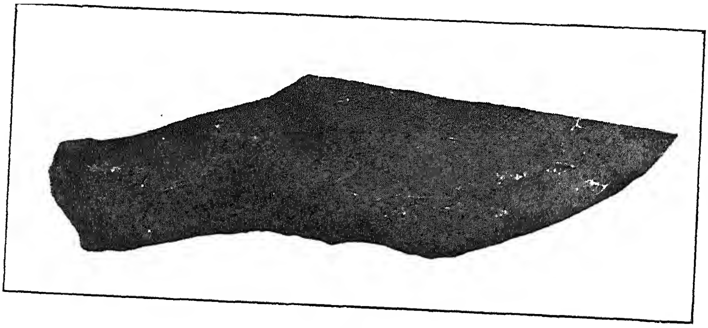

Fig. 4

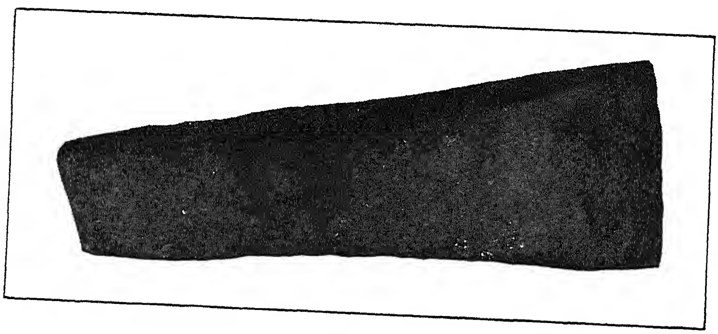

Fig. 5

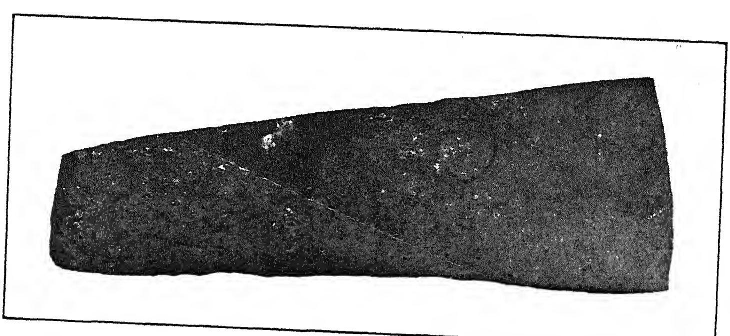

Fig. 6

Hawaiian adze: fig. 4, side view; fig. 5, top view; fig. 6, bottom view

used in the Tombs of the Kings and elsewhere as made of chert. "Siliceous limestone" would seem to be more appropriate than "sandstone" because the Moqattam series is typically one of limestone and because of the presence of the foraminifera and the secondary character of the silica.

Some particular features of the form of the Egyptian adzes are to be noted for comparison with those of Hawaii. There is a slight curvature of the whole tool, approximately that of the line of motion when in use. The proximal end has somewhat rounded edges and is of a size convenient to be grasped by the hand, as these implements were probably not attached to a wooden handle. The distal end is formed by a somewhat rounded cutting edge, with an angle of about 70°, the under surface of this being convexly curved. The upper side of my specimen is smooth and curved, advantage having been taken of a natural rift in the rock, and the under side is very similar. The two lateral sides are rough, the stone having been pecked away with no attempt at a smooth finish except on the manual portion. The cutting edge of the specimen in the National Museum has an angle of about 60°, but this appears to have been broken before it was much used, whereas the cutting edges of my specimen and that in New York show signs of considerable wear.

Hawaiian stone adzes are well known and are to be found in many museums of anthropology. An excellent description of these tools, with many illustrations from the large collection in the Bernice Pauahi Bishop Museum at Honolulu, is given by Brigham.[5] A specimen which was found near Kaneohe on the Island of Oahu, and which was given me in 1920, is shown in Figs. 4–6. It is fairly representative of these adzes, although they vary much in size and rather less in form. The Hawaiian adze was used for cutting wood, as in felling trees or making canoes and idols, and Brigham says that he has seen them in use as late as 1864.

The material is a very dense and fine-grained, almost black basalt, not a phonolite as stated by Brigham (op. cit., p. 10), a rock which is not certainly known to occur on the islands and which is usually much lighter in color than any of the adzes that I have seen either in the Bishop Museum or the National Museum. There are very few quarries of appropriate material, Brigham stating that the number "hardly exceeded half-a-dozen." Two well-known ones are on

[5] Brigham, W. T., *Ancient Hawaiian stone implements,* Mem. Bishop Mus. 1, no. 4:73–83, figs. 74–79, *pls. 53–57.* 1902.

Hawaii, one high up on Mauna Kea and the other at the bottom of the crater of Keanakakoi at Kilauea. Another is said to exist "far up the slopes of Haleakala" on Maui, and there are several on Kauai. Brigham knew of no quarries on Oahu, and it is possible that the specimen figured is from one of those on Hawaii, as all the stone of these two quarries is said to be dark-colored and very compact. A thin section of my adze shows that it is a fine-grained olivine-free basalt, composed almost wholly of numerous very small, short, and uniformly shaped tablets of labradorite (about Ab_1An_2) with very small irregular grains of slightly brownish augite. There are a few grains of quartz but no olivine, magnetite, or glass. This basalt, in its great denseness, freedom from phenocrysts and vesicles, and its microtexture and simplicity of mineral composition, differs from any of the basalts of Hawaii[6] or Oahu that I have studied. No chemical analysis of it has yet been made.

The adze figured here is of Brigham's type "with divergent sides and angular tang," and it closely resembles No. 3155 (Fig. 78 and Plate 55) of the Bishop Museum, which was also found on eastern Oahu. It is 21 cm. long, 8 cm. wide at the cutting edge, and about 5 cm. thick, except at the tang which is only 3 to 3.5 cm. thick. The angle of the cutting edge in my specimen is sharp and is about 60°. This angle seems to be about the average, although the angles shown by Brigham in his Fig. 74 vary considerably, as he states from 34° to 78°. The slightly curved upper surface and the much more convexly curved under surface of the distal cutting portion are well smoothed by grinding but are not polished; whereas the sides are chipped flat and only slightly smooth. The tang, both above and below, is roughly finished by chipping and has sharp edges. These Hawaiian adzes seem generally to have been attached to a wooden handle, as shown by Brigham in his Plate 60, but he is not very clear on this point.

The general resemblance in form between the Egyptian and the Hawaiian adze is seen in the collocated views of the two given in the accompanying illustrations, Figs. 1 and 4, the side views, showing the resemblance especially well. The unfinished Hawaiian adzes, such as Nos. 8, 18, and 19 on Brigham's Plate 58, on which the faces are not smoothed, are even more strikingly like the Egyptian. The slightly curved upper surfaces, the cutting edge of about the same

[6] WASHINGTON, H. S., *Petrology of the Hawaiian Islands*, several papers in Amer. Journ. Sci., vols. 5 and 6, 1923. It resembles most several from Mauna Kea, on Hawaii.

angle, the convexly curved under side of the distal end, and the smaller diameter and rough finish of the tang or manual portion, are all points of resemblance that cannot fail to impress themselves on one who studies the figures and even more so the objects themselves.

There has thus been evolved what is in essential features an almost identical tool, made of the most suitable local material, one used nearly five thousand years ago to excavate rather soft limestone, and the other used to cut wood up to within recent years. This may bear out Prof. Elliot Smith's thesis that some of the Polynesian and Pre-Columbian American culture originated in ancient Egypt after about 800 B.C. and was spread eastward by mariners. I am inclined to think, however, that the tools are of quite independent origin, and that the close resemblances between them are the resultants of the human mind having worked out the problem of rough cutting with hard stone in much the same way.

ENTOMOLOGY.—*A key to some South American bees belonging to the genus* Halictus *subgenus* Chloralictus. GRACE ADELBERT SANDHOUSE, University of Colorado, Boulder, Colorado. (Communicated by S. A. ROHWER.)

Although the metallic-colored bees of the Genus *Halictus*, subgenus *Chloralictus*, occur over a large part of the North American continent they are found in South America only along the Andes Mountains; some have been reported from Ecuador, Peru, and Chile, and a few species have evidently crossed the mountains into Argentina. These in general resemble the North American species very closely, there being no more difference between the species from North and South America than exists between many North American species.

The following key includes the females of the South American species in the collection of Professor T. D. A. Cockerell of the University of Colorado.

Abdomen green, color of head and thorax; (disk of propodeum with irregularly anastomosing rugae) . . . . *danicorum* Cockerell.
Adomen brown or black 1
1. Mesothorax opaque, microscopically tessellate between very close punctures . . . . *spinolae* Reed.
   Mesothorax shining or more sparsely punctured 2
2. Tegulae pale 3
   Tegulae dark 5
3. Head and thorax golden green; knees, tips of tibiae and tarsi red-testaceous *chrysonotus* Ellis.
   Head and thorax not golden green; legs dark 4

4. Stigma and nervures pale; disk of propodeum dull, the entire area covered with irregularly anastomosing rugae . . . . *paramorio* Friese.
   Stigma and nervures dark testaceous; disk of propodeum shining, plicate on base only; mesothorax more closely punctured . . . . *hypochlorus* Ellis.
5. Mesothorax coarsely punctured; flagellum dark; disk of propodeum subcrescentic, with anastomosing rugae . . . . *herbstiellus* Friese.
   Mesothorax weakly punctured; flagellum testaceous beneath; disk of propodeum shorter, shining, plicate on the base only. *exiguiformis* Ellis.

Halictus (Chloralictus) spinolae (Reed)

Since no recent or full description of *Halictus spinolae* (Reed) is readily available in this country, the writer gives the following:

Female—About 4.5–5 mm. long; head and thorax olive green; abdomen black; pubescence white, rather sparse. Facial quadrangle longer than broad; orbits converging below; antennae dark, flagellum testaceous beneath; front very closely punctured, giving an almost granular appearance; sides of face with more scattered punctures; supraclypeal area and upper part of clypeus microscopically tessellate, sparsely punctured, with a brassy reflection; lower half of clypeus black; mandibles black. Mesothorax dull, finely tessellate and very closely punctured; punctation of scutellum similar to that of the mesothorax, two polished spots on the disk; disk of propodeum with fine, irregularly anastomosing rugae, making a reticulate surface; tegulae dark brown, impunctate; truncation well defined laterally. Abdomen obovate, shining, impunctate; pubescence sparse, especially on the first segment; apical margins of segments narrowly testaceous. Wings clear, anterior wing 3.5 mm. long; stigma and nervures testaceous; second submarginal cell higher than broad, receiving the first recurrent nervure near the apex; third submarginal gently contracted above, about one and one-half times as long as second on the marginal. Legs black with dull white hairs; hind spur pectinate with four moderately long teeth.

The following locality is new: 1 female (Foothills) Lima, Peru, December 5 (C. H. T. Townsend).

The description given above is based on this Peruvian specimen, which was found to be identical with a specimen of *spinolae* from Chile, determined by C. Schrottky.

BOTANY.—*New or little known Melastomataceae from Venezuela and Panama.* H. Pittier.

In the course of my investigations on the flora of Venezuela, in which I have been so efficiently helped through the coöperation of my friend Dr. Alfred Jahn, I am constantly coming across plants which have never been catalogued. These are of course more interesting to me when they belong to groups with which I have become familiar during former studies.[1]

[1] See Pittier, H. *New or noteworthy plants from Colombia and Central America*, parts 1–8, in Contr. U. S. Nat. Herb. 12-20. 1909–1922.

I have described a few of these new species, for which there is no proper place in my present official publications. Besides, I have now and then had the opportunity to examine some of my former collections in Central America, Panama and Colombia, and have found among them several undescribed forms. Last, but not least, rare species established by older botanists are sometimes brought to light again, or others are found upon further examination to have been misplaced or misunderstood, good opportunities thus being offered for completing or correcting the original descriptions. The present paper deals with ten new or imperfectly known species of Melastomataceae from Venezuela and Panama.

Chaetolepis sessilis Pittier, n. sp.

Subprostrata, ramosissima, ramis diffusis, gracilibus, acute tetragonis, ad nodos sparse setulosis caeterum glabris; foliis sessilibus, oblongis, obsolete trinerviis, glabris, basi attenuatis, margine tenuiter remoteque glanduloso-denticulatis, apice subacutis, subtus tenuissime albo-punctatis; floribus breviter pedicellatis, ad apices ramulorum corymbosis; calyce tubuloso-campanulato, tubo leviter costato, sparsissime setuloso, dense albo-punctato, lobulis triangularibus, margine purpureo-setulosis, cum setis 2–3 rigidis purpureis basi tuberculatis alternantibus; petalis luteis, glabris, suborbicularibus, basi brevissime unguiculatis apice longe unisetosis; staminibus subaequalibus, filamentis glabris, vix attenuatis, antheris sublinearibus uniporosis, basi in connectivum articulatum leviter contractis; stylo glabro, staminibus multo breviore; capsula ovoidea, leviter costata, sparsissime setulosa, pedicellata.

Caules 10–20 cm. longi, adscendentes. Folia 0.6–4 cm. longa, 0.4–0.6 cm. lata, rigidiuscula, margine subrevoluta. Pedicelli 0.4–0.6 mm. longi. Calycis tubus 4–5 mm. longus, lobi 2.5 mm. longi, basi 1.5 mm. lati. Petala 4–5.5 mm. longa lataque, seto terminale 1.5–2 mm. longo. Filamenta circiter 5.5 mm. longa; antherae 4.5 mm. longae. Capsula 6 mm. longa, 4 mm. diametro.

VENEZUELA: Páramo de Aricagua, 3200 m., Mérida, fl. March 31, 1922, *A. Jahn* 1037 (type).

This species of the Section *Euchaetolepis* differs from *C. alpina* Naud., with which it has its greatest affinities, in its sessile leaves which are always oblong and without marginal bristles, its pedicellate flowers with elongate calyx sparsely covered with short appressed hairs, its orbiculate petals with a very long apical bristle, and its more elongated anthers. The leaves and calyx, moreover, are covered with white glandular dots.

The following key gives the differential characters of the species of *Chaetolepis* which are at present known to occur in Venezuela.

Calyx lobes without intermediary appendages; petals obtuse at the apex.
 Anthers oblong; leaves 5–8 mm. long, papillose beneath.
 1. *C. Lindeniana* Cogn.
 Anthers ovoid; leaves 3–5 mm. long, densely hispid-hairy beneath
 2. *C. alpestris* Cogn.

Calyx lobes alternating with aculeate bristles or teeth.
 Branchlets covered with a hairy purplish indument; leaves ovate, broad at the base and with acute apex; calyx tube slightly villous.
 3. *C. anisandra* Cogn.
 Branchlets glabrous or slightly hairy.
 Leaves sessile, not ciliate, covered as is the calyx with white glandular dots.................................. 4. *C. sessilis* Pittier.
 Leaves distinctly petiolate.
 Flowers almost sessile, the petals ovate and acuminate; leaves with crenulate and ciliate margin................5. *C. alpina* Cogn.
 Flowers pedicellate, the petals obovate and obtuse; leaves entire.
 6. *C. microphylla* Cogn.

Tibouchina brachyanthera Pittier, n. sp.

Fruticosa, caule tereti, ramis ramulisque longe denseque squamoso-villosis, cortice deciduo; ramulis erectis; foliis petiolatis, coriaceis, rigidis, supra obscure viridibus subtus flavicantibus; petiolo longe denseque squamoso-villoso; laminis ovato-lanceolatis, 5-nerviis, basi rotundatis, apice apiculatis, supra inter nervos adpresse villosa, subtus nervis exceptis squamoso-villosis sparse villosis, margine dense villoso-ciliatis; nervis marginalibus supra obsoletis, subtus tenuibus, 3 interioribus supra valde impressis, subtus prominentibus; floribus majusculis, subsessilibus, ad apices ramulorum aggregatis; bracteis obovatis, acutis, densissime adpresse canescenterque squamosis, supra medium connatis, interioribus quam exteriorum pars libera longioribus; calycis tubo basi glabro, apice squamis magnis lanceolato-apiculatis marginibus setuloso-serrulatis coronato; segmentis rigidis, lanceolato-triangularibus, apice longe apiculatis, extus creberrime adpresse hispidis, tubum aequantibus; petalis obliquis, late obovatis, apice rotundatis, sparse ciliatis; staminibus paulo inaequalibus, filamentis glabris, antheris brevibus, subattenuatis vix arcuatis, connectivo glabro basi producto, bilobato; ovario elongato-oblongo, basi glabro, 5-sulcato, apice longiuscule canescenti-setuloso; stylo filiformi, longiusculo, glabro, superne arcuato; capsula matura deest.

Petiolus 2–5 mm. longus; laminae 3–5 cm. longae, 1.3–2 cm. latae. Bracteae exteriores circa 4 mm., interiores 6–6.5 mm. longae. Calycis tubus 6–7 mm. longus, segmentis 6.5 mm. longis, 2.2 mm. latis. Petala circa 12 mm. longa, 9 mm. lata. Staminum filamenta 6–7 mm. longa; antherae 4.5 mm. longae, connectivo infra loculos 1–1.5 mm. longo. Ovarium 5 mm. longum, 1.5–2 mm. crassum; stylus 13.5 mm. longus.

VENEZUELA: Torococo, Trujillo, 1100 m., in sunny spots, fl. January 11, 1922, *Jahn* 755 (type).

This species, which, is apparently the third known of the group of the true *Tibouchinae*,. differs from *T. aspera* Aubl. and its varieties in the form and indument of its apiculate leaves, the very short bracts, the calyx segments equal to the tube, the smaller petals, and the shorter stamens, as well as by the general appearance. It is at once distinguished from *T. spruceana* Cogn. by its 5-nerved leaves, and likewise by its smaller petals, which are ciliate at the apex, its shorter style, etc. The three species of the section are found in Venezuela and are distinguished one from the other by the following characters:

Eutibouchina.

Anthers straight, short-attenuate, 4–5 mm. long; leaves 5-nerved, ovate-lanceolate, apiculate; Andes.................. *T. brachyanthera* Pittier.

Anthers arcuate, long-attenuate.

Leaves 5-nerved; petals 14–16 mm. long, ciliate at apex; anthers 7–10 mm. long; Guayana, Miranda, Zulia............ *T. aspera* Aubl.

Leaves 3-nerved; petals 20–25 mm. long, not ciliate; anthers 6–7 mm. long; Upper Orinoco.................... *T. spruceana* Cogn.

Desmoscelis mollis Pittier, n. sp.

Planta robusta, caule erecto, modice ramoso, tetragono, ramis ramulisque longe molliter villoso; foliis petiolatis, pro genere majusculis, petiolo breve lateque hirsuto, laminis 7-nerviis, oblongo-lanceolatis, basi rotundatis, apice subacutis, supra dense villosis pilis e basi crassissima conspicua immersa productis, subtus pallidioris, villosis, indistincte nigro-punctatis; floribus pedicellatis, alaribus vel axillaribus; pedicellis gracilibus calycibusque longissime densissime molliterque villosis; calyce ovoideo, basi rotundato, lobulis anguste triangularibus apice longissime apiculatis; petalis roseis, obovatis, obliquis, apice rotundatis, margine sparse ciliolatis; staminibus glabris, alternatim majoribus minoribusque, filamentis gracilibus, flexuosis, purpureis; antheris majoribus leviter arcuatis, apice obtuso vix attenuatis vel truncatis, purpurascentibus, connectivo infra loculos elongatissimo, antice appendicibus duobus longissimis producto; minoribus brevibus, truncatis, connectivo breviusculo, antice in calcar breve latumque integrum producto; ovario calyci semiadherente, apice setis rigidis dense coronato; stylo flexuoso, purpurascente, apice in stigma flavum punctiforme producto; capsula ignota.

Caulis 0.50–0.75 m. alta. Folia patula, petiolo 0.2–0.7 cm. longo, laminis membranaceis 2.5–7 cm. longis, 1.5–3 cm. latis. Flores numerosi. Pedicelli 3–5 mm. longi. Calycis tubus 4.5 mm. longus, 2.5 mm. diam.; lobuli 3.5–3.8 mm. longi, basin 1.4–1.6 mm. lati. Petala 7–7.5 mm. longa, 4 mm. lata. Staminum filamenta 4–6 mm. longa; antherae majores 2–2.8 mm. longae, connectivo infra loculos 2–2.3 mm. longo, appendicibus 2.3–2.5 mm. longis; antherae minores 1–1.8 mm. longae, appendiculo circa 0.7 mm. longo. Ovarium 4.2 mm. longum; stylus circa 6 mm. longus.

VENEZUELA: Savannas of Mene Grande, Zulia, in low, damp places, fl. October 28, 1922, *Pittier* 10578 (type).

This is the first *Desmocelis* reported from Venezuela, but it is probable that we also have *D. villosa* Naud., one form of which (*D. villosa purpureo-violacea* Cogn.) has been indicated by Karsten as growing in the plains of Villavicencio in Colombia. The above-described species differs from the latter in its distinctly petiolate and larger leaves, smaller flowers, longer filaments and anterior appendices of the connective, much shorter anthers and connectives, etc. The large and small anthers alternate regularly. The hairs on the upper face of the leaves issue from an elongated tubercle, brown in colour, immersed in, or adhering to, the parenchyma.

Monochaetum Jahnii Pittier, n. sp.

Ramis teretibus gracilibusque longiuscule hispidis; foliis parvis longiuscule petiolatis, plerumque late ovatis, basi truncatis subemarginatisve, apice acutis, 7-plinerviis, utrinque densiuscule hirsutis, pilis sparsissime glandulosis;

floribus cymosis, breviter pedicellatis, pedicellis calycibusque tubi apice pilis glandulosis coronato excepto glaberrimis; calycis lobis brevibus ovato-obtusis, longe ciliatis; petalis roseis, orbiculatis, glanduloso-ciliatis, densiuscule punctatis; staminibus 8, antheris subrostratis; ovario glabro, calyci adherente; stylo apice truncato.

Frutex ramosissimus, ca. 1 m. altus; rami gracili, angulosi, fusco-virides. Petioli 4–9 mm. longi, dense hirti; laminae supra solute virides, subtus pallidiores, 1.5–2.5 cm. longae, 1–1.5 cm. latae. Pedicelli ca. 2 mm. longi; calycis tubus 5 mm. longus, 3.5 mm. latus, purpurascens, lobi 1–1.5 mm. longi; petala 5.5 mm. longa lataque; filamenta staminorum majorum 4.5 mm. longa; antherae majores ca. 4 mm. longae, cauda cultriformi arcuata basi crassiore 5 mm. longa; antherae minores erectae, 3–3.5 mm. longae, cauda breviore, refracta, lineari; stylus ca. 5 mm. longus.

VENEZUELA: Between Palmira and Páramo de la Sal, 2700 m., Andes of Mérida, fl. September 1, 1921, *Jahn* 607 (type).

This elegant species should be placed near *Monochaetum glanduliferum* Triana, from which it differs in the longer, sparsely glandular indument, the leaves with longer petioles and also scarcely glandular, and the perfectly glabrous calyx tube ending in a dense crown of glandular hairs, and with glabrous, ciliate lobes. The stamens are also very distinct in shape and size and the drawing of the anthers differs from that accompanying the original description of *M. glanduliferum*.

MONOCHAETUM DISCOLOR Karsten ex Triana, Trans. Linn. Soc. **28**: 63. 1871.

A striking and not very well-known species, the description of which can be completed as follows:

Petioli 2.5–4 mm. longi (sed nunquam 6 mm.); laminae 15–18 mm. longae, 7–10 mm. latae, subtus canescentes et strigillosae. Flores numerosi, pedunculis adpresse setulosis 5–10 mm. longis. Calycis tubus subglobosus, indistincte 8-costatus, circa 4 mm. longus, lobulis acuminato-triangularibus tubum subaequantibus vel longioribus, basi 3–3.5 mm. latis. Petala obovata, basi sensim cuneata, apicem versus minute strigosa, margine ciliolata, 13 mm. longa, 8 mm. lata. Stamina inaequalia, filamentis 6–7 mm. longis, planis, plusminusve distortis, antherarum caudis loculam subaequantibus vel interdum multo longioribus foliaceisque. Stylus 7–8 mm. longus, glaber; stigma punctiforme.

VENEZUELA: Agua de Obispo, Trujillo, 2500 m., fl. September 24, 1922, *Jahn* 1165.

Up to the present, eight species of the genus *Monochaetum* have been reported from Venezuela, all from the andine or subandine belts with the exception of *M. multiflorum* Naud., which was collected near Esmeralda on the open plains of the Orinoco by Bonpland, but is also indicated as growing in the Quindio, an elevated region of Colombia. These Venezuelan species can be distinguished by the following key.

Monochaetum.

Calyx lobes deciduous (*Grischowia*).

Branchlets densely villous; leaves 7-9-pilinerved; calyx 12–15 mm., the lobes 15–18 mm. long........................1. *M. hirtum* Triana.

Branchlets appressed-setulose and slightly hirsute.
Leaves 7-plinerved; calyx tube 1 cm., lobes up to 1.8 cm. long.
2. *M. Humboldtianum* Hook.
Leaves 5-plinerved.
Petals entirely glabrous, 2–3 cm. long.....3. *M. latifolium* Naud.
Petals ciliate, 1 cm. long or less............4. *M. meridense* Naud.
Calyx lobes persistent (*Eumonochaetum*).
Pubescence glandular, long; calyx glabrous, its tube with a crown of glandular bristles at the apex; leaves 7-plinerved.
5. *M. Jahnii* Pittier.
Pubescence eglandular.
Branchlets covered at the base with bristles, these scaly; leaves tri-plinerved, 15–18 mm. long.............6. *M. discolor* Karst.
Branchlets more or less hairy.
Hairs simple; calyx lobes much shorter than the tube.
7. *M. Bonplandii* Naud.
Hairs more or less feathery; calyx lobes much longer than the tube.
8. *M. multiflorum* Naud.

MARCETIA ANDICOLA Naudin, Ann. Sci. Nat. III. **15**: 44. 1851.

Fruticulosa, caulibus adscendentibus, teretiusculis, ramosissimis, cortice laeve, cupreoso, leviter excoriato; ramis juvenioribus subangulosis, dense glanduloso-hirtellis; foliis brevissime petiolatis, integris, 5-nerviis, valde revolutis, apice acutis, utrinque glanduloso-puberulis supra impunctatis; floribus axillaribus, solitariis, brevissime pedicellatis; calyce breviter glanduloso-hirtello, tubo ovoideo segmentis lineari-subulatis remotiusculis paulo longiore; petalis roseis, ovato-lanceolatis, basi uniauriculatis, apice acutissimis; staminibus leviter inaequalibus, antheris basi biauriculatis omnino exsertis; ovario 4-loculare; stylo apice lateraliter acutato; capsula globosa, leviter 8-costulata, sparse glanduloso-hirtella.

Fruticulus 40–80 cm. altus. Petioli 0.5–1 mm. longi; laminae 6–9 mm. longae, 5 mm. latae. Pedicelli 1–1.5 mm. Calycis tubus 3–3.5 mm. longus, apice 3 mm. latus; lobi 1.5–3 mm. longi, basi 1 mm. lati. Petala 9–9.5 mm. longa, 4.5–5 mm. lata. Filamenta 6.5–7 mm. longa, antherae 3–4.5 mm. longae, basi 1 mm. crassae. Stylus 12 mm. longus. Capsula 3.5–4 mm. diam.

VENEZUELA: State of Mérida, 2300 m., *Funck & Schlim* 1200 (type). Páramo Quirorá, 3000 m., Mérida, fl. and fr., October 8, 1921, *Jahn* 7C8. Páramo La Trampa, 2100 m., Mérida, fl. March 12, 1922, Jahn 990.

This species, known locally under the name of "*romero*," which other species belonging to the Andes also bear, has probably been confused with *Marcetia juniperina* and *M. cordigera* DC. It differs from the latter by its leaves, which are petiolate and broader, and by its decidedly larger flowers, from the former also by the distinctly heart-shaped leaves, the five nerves of which are clearly visible in the fully developed blade. Moreover, it lacks the superfoliary punctations indicated as being characteristic of *M. juniperina* and the calyx tube is longer than the segments thereof; the petals are very sharp-pointed but not long-acuminate, and the stamens stand out the whole length of the anthers. These differences are accentuated when the dimensions of the various parts are taken into account.

Naudin distinguished the *Marcetia* collected in Merida by Funck and Schlim (no. 1200) under the name of *M. andicola,* but this was later reduced by Cogniaux to the rank of a variety of *M. cordigera.* We take Naudin's plant to be the same as the one described here, and believe that it cannot be assimilated with *M. cordigera* on account of having petiolate leaves, nor with *M. juniperina,* primarily because of these being 5-nerved. Certainly it shows a close relationship with the latter, but still it differs from it sufficiently to justify its being considered as a distinct species.

After writing the above, I had the opportunity, thanks to the kindness of Professor Lecomte, of the Museum of Natural History in Paris, of comparing the materials collected by Dr. Jahn with the type of *Marcetia andicola* Naudin. Thus I was able to convince myself that this and Jahn's collections are identical, and moreover, that the species of Naudin should not be mistaken for *Marcetia cordigera* DC. nor even be considered as a variety of it. This opinion is further confirmed by a careful comparison with the original descriptions and analytical sketches of Naudin, of which latter Prof. Lecomte also had the kindness to send me tracings.

Miconia rufostellulata Pittier, n. sp.

Frutescens, ramis gracilibus petiolis inflorescentiisque dense stellulato-furfurascentibus; foliis membranaceis, parvis, 3–5-nerviis; petiolo breviusculo, laminis ovato-oblongis, basi rotundatis, apice breve acuminatis, margine obscure crenulatis, sparse ciliatis, supra laete viridibus sparsissime pilosis stellulatisque, subtus purpurascentibus, secus nervos creberrime demum sparse stellulatis; inflorescentiis ramulis lateralibus oppositis bifoliatisque suffultis, paniculatis; floribus pedicellatis, tetrameris, minutis, brevissime pedicellatis; calyce tubuloso-campanulato, eleganter rufo-stellulato, limbo 4-lobulato, lobulis acutis apice subulatis; petalis albis, obovatis, apice oblique rotundatis et emarginatis; staminibus ut petalis reflexis, antheris basi dilatatis subbiauriculatis; stylo glabro.

Frutex ad 1.5 m. altus. Petiolus 0.3–0.8 cm. longus; laminae 3–8 cm. longae, 1.5–3 cm. latae. Panicula 1.5–3.5 cm. longa. Pedicelli 0.5–1 mm. longi. Calycis tubus 1.5–2 mm. longus, lobuli 0.8 mm. longi. Petala 2.4 mm. longa, 1.4 mm. lata. Antherae circa 2 mm. longae. Stylus 3.5–4 mm. longus.

PANAMA: Forests around Pinogana, southern Darién, fl. April 16–21, 1914, *Pittier* 6535 (type).

Miconia rufostellulata belongs in the Section *Eumiconia,* in the series *Paniculares,* and should be placed near *M. brevipes* Benth., from which it differs in the indument, the coloring of the leaves, the larger petals, and other characters.

Clidemia gracilis Pittier, n. sp.

Ramis lignosis, compressis subalatisque, glaberrimis; foliis sessilibus, valde disparibus, majoribus quam opposita 8–16-plo longioribus, ovatis ovato-oblongisve, basi rotundatis subemarginatisve, apice breve sensimque acuto-acuminatis, margine integerrimis, 5-nerviis, supra glaberrimis laevibusque obscure viridibus, subtus cinereo-viridibus, ad nervos nervulosque

pubescentibus; nervis nervulisque supra prominulis subtus venulisque valde prominentibus; foliis minoribus ovatis, acuminatis, 3-nerviis; paniculis axillaribus, longissime gracillime pedunculatis, subnuatantibus; ramulis oppositis, divaricatis, 1–2-floribus, sparse puberulis; floribus ignotis; bacca globosa, puberula, in sicco leviter 10-costulata.

Arbuscula ad 1.5 m. alta. Internodia 2–4.5 cm. longa. Folia majora 11–19 cm. longa, 4–8 cm. lata, minora 1–2 cm. longa, 4–8 mm. lata. Panicula ad 16 cm. longa, depauperata, ramulis 4–5 cm. longis; baccae 4 mm. diam. bracteolis 2 minutis suffultae.

PANAMA: Head of lake in Gatun Valley, Canal Zone, in shady forest, fl. and fr. August 16, 1914, *Pittier* 6748 (type).

This species, of which I have at hand only fruiting specimens, is very closely related to *Clidemia dispar* (O. Berg) Cogn. of the Section *Calophysoides*, collected in eastern Peru by Spruce. It differs in the compressed, glabrous branchlets, the much larger leaves with entire margin and with appressed-pubescent, not stellate, nerves, and finally in the long, slender and few-flowered inflorescences. According to the notes taken on the spot when collecting the plant, the flowers are small and white. It is likely that some will be found on the specimens elsewhere distributed.

CLIDEMIA GRANDIFOLIA Cogn. in DC. Monogr. Phan. **7**: 1018. 1891.

My no. 8917 coincides with the description of this species as to the characters of the branchlets, leaves and inflorescence, but it differs slightly as to those of the flowers. It seems likely, however, that the plant is specifically identical with the one described by Cogniaux.

I have noted the following complementary data:

Frutex 2–3 m. altus, erectus, paucirameus, ramis robustis. Petioli crassi, 5–10 cm. longi; laminae 15–25 cm. longae, 14–21 cm. latae, supra sparsissime breviterque setulosae, subtus ad nervos sparse furfuraceae, demum glandulis minimis translucidis adspersae. Paniculae in axillis fasciculatae, laxae, subnutantes. Pedicelli 5–6 mm. longi. Calyx tubuloso-urceolatus, 3.5–4 mm. longus, basi 4-bracteolatus, dentibus interioribus nullis, exterioribus 0.5 mm. longis, obtusis; bracteolae ovatae, obtusae vel acuminatae, circa 1.5 mm. longae. Petala alba, oblonga, obtusa, 2–2.2 mm. longa, 1.2–1.3 mm. lata. Filamenta 1.7 mm. longa; antherae 2.5 mm. longae, oblongae, basi apiceque acuminatae. Stylus 6 mm. longus, basi setosus.

Type collected between Maracay and Choroni, Venezuela, 1300 m., (*Fendler* 2263). Our samples were collected on the hills of Guaremales, 450 m., near Urama, Carabobo, fl. July 2, 1920, *Pittier* 8917.

Ossaea trichocalyx Pittier, n. sp.

Fruticosa, ramis obtuse tetragonis, glabris vel minutissime furfurascentibus; foliis membranaceis, integerrimis, modice petiolatis, imo magnis, petiolis angulosis, glabris, laminis ovatis, septuplinerviis (junioribus 5-plinerviis ?), basi rotundatis in petiolum decurrentibus, apice sensim acuminatis, supra glaberrimis subtus ad nervos venasque minute ferrugineo-furfurascentibus; floribus 4-meris, ut in *Henriettea* supra nodos defoliatos 6–12-fasciculatis racemulosisve brevissime pedicellatis; calyce urceolato-tubuloso, extus furfurescente, limbo brevissimo, dentibus exterioribus longe productis, spinuloso-setaceis; petalis albis, glabris, ovato-oblongis, apice rotundatis

setis 1–4 munitis; stylo staminibus duplo longiore, stigmate minutissime papilloso; bacca subglobosa, 5-locularis.

Frutex ad 2 m. altus. Petiolus 0.7–4.5 cm. longus; lamina 10–25 cm. longa, 4–11 cm. lata. Pedunculus communis 0.8–1 cm. longus; pedicelli 0.5–1 mm. longi. Calycis tubus 2.5 mm. longus, dentes exteriores 2–2.5 mm. longi; setae terminales 1–1.5 mm. Petala 2.2–2.5 mm. longa, 1.2 mm. lata. Antherae apice uniporosae 2 mm. longae.

PANAMA: Caño Quebrado, Canal Zone, in shady forest, fl. June 14, 1914, *Pittier* 6667 (type).

On account of the cauline flowers and general appearance, this species was placed first in the genus *Henriettea.* But further investigations showed the presence of fibro-vascular bundles both in the cortical layers and in the pith, so that if this character, given by Krasser,[2] is to be considered as constant and conclusive, there is no choice but to place the plant under *Ossaea,* Section *Euossaea.* It differs, however, from all the other species of this group, first in its leaves, glabrous and smooth above and more or less fuzzy beneath, and then in the prominent calyx teeth, provided with tiny spinelike articulate hairs up to the apex, which ends in a long bristle, and in the petals, also bearing from one to four long setae on their rounded upper end.

SCIENTIFIC NOTES AND NEWS

DR. GEORGE OTIS SMITH was reappointed Director of the U. S. Geological Survey, effective September 24, when the Coal Commission, of which he was member, was dissolved. P. S. SMITH, acting director, has returned to his former position of administrative geologist of the Survey.

The Priestley Medal, given every third year by the American Chemical Society to an American chemist for marked service to science, was awarded to DR. IRA REMSEN, President-emeritus of The Johns Hopkins University, at the sixty-sixth convention of the society, recently held at Marquette University.

ALEXANDER WETMORE, Bureau of Biological Survey, has returned from Hawaii where he has had charge of an expedition organized by the Biological Survey and the Bishop Museum of Honolulu, in cooperation with the U. S. Navy, to prosecute a general scientific survey of the Leeward chain of the Hawaiian group, and Johnston and Wake Islands.

DR. TRUMAN MICHELSON, of the National Museum, returned last month from his season's field work in Labrador. In studying the origin of the Indians of that region and their dialects, Dr. Michelson made important discoveries regarding the Nascapi language, and the ethnological diffusion in the Labrador peninsula.

[2] In Engl. & Prantl, *Nat. Pflanzenfam.* 3^7:182. 1893.

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CRYSTALLOGRAPHY.—*A note on the crystal structures of lithium iodide and rubidium fluoride.* Ralph W. G. Wyckoff and Eugen W. Posnjak, Geophysical Laboratory.

A study of the crystal structures of all of the alkali halides, except rubidium fluoride, has been published;[1] further powder data upon all of them have also been given recently.[2] The results of the study of lithium iodide in these two investigations, however, are conflicting, and the published data upon rubidium fluoride are not in accord with the writers' preliminary observations. The present paper is devoted to a discussion of these discrepancies.

The structure of lithium iodide. As ordinarily prepared, lithium iodide crystallizes as a hydrate. The trihydrate, stable up to ± 75°C., yields on heating a di- and finally a mono-hydrate. The anhydrous salt, which is excessively hygroscopic, is obtained only by holding the monohydrate[3] at temperatures above 300°C. The specimen used in the first determination[1] was prepared by melting anhydrous lithium iodide, grinding the solidified salt while still hot in an oven, and immediately introducing it into a glass specimen tube which was then sealed. Even under these conditions the resulting powder photographs showed that probably not less than 20 per cent of the sample had hydrated. The crystalline powder used in the other study[2] of lithium iodide was obtained by evaporating a solution of lithium iodide over sulfuric acid. It is known that the trihydrate is produced[4] at 0°C. by this procedure, and both the known properties

[1] R. W. G. Wyckoff, Journ. Washington Acad. Sci. **11**: 429. 1921. E. W. Posnjak and R. W. G. Wyckoff, *ibid.* **12**: 248. 1922.

[2] W. P. Davey, Phys. Rev. **21**: 143. 1923.

[3] F. Auerbach and J. F. Brislee in Abegg's Handbuch der anorganischen Chemie **2**, Abt. 1: 130.

[4] Gmelin-Kraut-Friedheim, Handbuch der anorganischen Chemie **2**, Abt. 1: 258.

of these hydrates and experiments by the writers indicate that an anhydrous product is not obtained at room temperature. It must consequently be concluded that the specimen employed in this second determination was not the anhydrous compound.

This conclusion is fortified in three directions. In the first place it has been shown[1] that the interatomic distances in all of the other alkali halides (rubidium fluoride was not investigated) are purely additive and can, if desired, be calculated through the medium of "atomic radii"[5] for these particular cystals. An acceptance of this second structure[2] for lithium iodide would show it (see, however, the discussion of rubidium fluoride given below) to be the only deviation from a closely exact agreement with the requirements of this additive rule: The nearest approach of lithium and iodine atoms according to this structure is 3.537Å, that required by the rule of additive interatomic distances, which is probably accurate for the rest of the alkali halides at least to within 1 per cent, is 3.01Å.

In the second place the structure of lithium iodide as found[1] upon fused material gives a "sodium chloride arrangement" of atoms in which the distance from lithium to iodine atoms is in substantial agreement with the additive rule (Li to I = 3.015Å). The density calculated from this structure (ρ = 4.03) likewise agrees with that determined[6] by the usual methods (ρ = 4.061). In the originally published results of this study it was indicated that the calculated intensities of reflection are not in so good accord with the intensities of the observed powder lines as is generally the case. A careful reëxamination of these films shows that the strongest line of the hydrated product has practically the same position as the 100 (2) reflection from the anhydrous lithium iodide; when a correction is made for the intensity contributed by this extraneous line there is complete agreement of calculated intensities with those observed upon the films. The data upon which this assignment of structure was based are shown in Table I. Other lines appeared upon the photographs but their accurate measurement was prevented by the nearness of hydrate reflections. No corrections[7] were applied for the absorption of lithium iodide and great accuracy is not claimed for the spacing measurements.

The observed intensities of reflections in the photographs of the second determination[2] disagree with those to be expected from the

[5] W. L. Bragg, Phil. Mag. **40**: 169. 1920.

[6] P. G. Baxter, Am. Chem. Journ. **31**: 558. 1904.

[7] O. Pauli, Zeitsch. f. Krystal **56**: 591. 1921–22.

assigned structure (Table II). The calculated intensities were obtained with the expression[8]

$$I \propto \left(\frac{d_{hkl}}{n}\right)^{2.35} \times s \times \overline{4(R \pm X)}^2$$

This formula, involving as it does the rule of "normal decline" and a proportionality between the number of electrons in atoms and their

TABLE I.—POWDER PHOTOGRAPHIC DATA UPON LITHIUM IODIDE

INDICES	SPACING	a_o	INTENSITY		REMARKS
			Observed	Calculated	
(hkl)	Å	Å			
....	4.50	....	5	....	Hydrate line
111(1)	3.50	6.06	10−	95,000 units	
100(2)	3.06	[6.12]	10	59,000	Hydrate line also
....	2.47	....	1	....	Hydrate line
110(2)	2.14	6.06	6	52,000	
113(1)	1.80	5.99	6	61,700	
100(4)	1.52	[6.08]	1	11,600	
133(1)	1.37	6.00	3	31,800	
112(2)	1.23	6.04	2	28,800	
		6.03Å average			

TABLE II.—INTENSITY DATA UPON LITHIUM IODIDE

INDICES	INTENSITY	
	Observed	Calculated
111(1)	3	24
100(2)	15	15
110(2)	10	13.3
311(1)	2	15.8
111(2)	3	5.3
100(4)	1.5	2.9
133(1)	1	8.1

scattering powers,[9] cannot possibly give quantitatively accurate results, but experience with different crystal structures, the rest of the alkali halides for instance, indicates that they are qualitatively correct.

From these different lines of evidence it seems necessary to conclude that the substance used in the second determination[2] of the

[8] R. W. G. WYCKOFF and E. W. POSNJAK, Journ. Am. Chem. Soc. **44**: 30. 1922. R. W. G. WYCKOFF, *op. cit.*

[9] W. H. and W. L. BRAGG, *X-rays and crystal structure*, London, 1918.

structure of lithium iodide was not the anhydrous compound and that the resulting experimental data lead to an erroneous determination of its crystal structure. From this standpoint, then, the fact that one or more compounds, none of which probably forms cubic crystals, could give as many as 20 lines which agree in position with a simple cubic arrangement is another and striking illustration of the dangers that arise from using unaided powder photographic data in determining the atomic arrangement in crystals.

The structure of rubidium fluoride. At the time of their study of the structures of the other alkali halides, several unsuccessful attempts were made by the writers to obtain the structure of rubidium fluoride. The material produced by fusing preparations of rubidium fluoride was found to be essentially isotropic[10] but so hygroscopic that it altered immediately upon exposure to air. For this reason it was impossible with the prevailing experimental facilities to obtain powder photographs showing lines belonging to the isotropic fluoride. The product used in the published determination[2] was a well-crystallized preparation made by a simple desiccation of a solution of rubidium fluoride. The writers' experience with rubidium fluoride leads them to question the identity of this crystalline material with anhydrous rubidium fluoride. Two other factors also suggest that this structure may not be that of the anhydrous salt.

Although the interatomic distances are additive for the caesium halides having the structure here ascribed to rubidium fluoride, there is no such agreement in this latter case (calculated distance = 2.80Å; observed = 3.172Å). Accepting the first assignment of structure[1] to lithium iodide, this disagreement would then be the only one among all of the alkali halides.

The observed intensities of the reflections upon which this determination of structure is based do not agree with those calculated for the stated atomic arrangement. This is shown by the data of Table III. The intensities of column 3 have been calculated with an expression analogous to the one used for lithium iodide.[8]

Summary. It is pointed out that the material used in a recent determination[2] of the structure of lithium iodide was not, in all probability, the anhydrous salt, that the observed intensities of the diffraction lines obtained from this preparation conflict with those calculated for the assigned structure, and that its interatomic distances do not agree with those to be expected from crystals of lithium

[10] The optical properties of these substances were obtained by H. E. Merwin.

iodide. This study of lithium iodide thus seems to be another example of the difficulties that arise from the use of the unaided powder diffraction technique in the determination of the structures of even simple crystals. Additional experimental data obtained by the present writers in a previous determination of lithium iodide are included. It is also pointed out that the intensities of the powder lines from rubidium fluoride and the distances between fluorine and rubidium atoms are not in agreement with those to be expected from the structure which has been given to this crystal.

TABLE III.—INTENSITY DATA UPON RUBIDIUM FLUORIDE

INDICES	INTENSITY	
	Observed	Calculated
100(1)	10	10
110(1)	8	27.5
111(1)	2	3.7
100(2)	1	6.2
110(2)	0.75	5.4
111(2)	Absent	2.2
120(1)	3	6.1
112(1)	1.5	15.5

Note: Only intensity calculations upon the more important reflections are reproduced in Tables II and III.

BOTANY.—Pseudophoenix insignis, *a new palm from Haiti, and two other new species from the West Indies.* O. F. COOK, Bureau of Plant Industry.

The generic type is *Pseudophoenix sargentii* Drude, a native of the Florida Keys. The genus has been considered as monotypic and is without any close relatives, so that it has been placed in a separate family, Pseudophoenicaceae. Even in the wider sense of family relationships, the Pseudophoenicaceae apparently are not allied to any North American palms, but may have remote affinities with the ivory palms and wax palms of South America. Hence the finding in Haiti of a new species of *Pseudophoenix*, of much greater size than the Florida species and with other distinctive characters, seemed worthy of note.

The Haitian *Pseudophoenix* is a large palm that grows abundantly in dry open forests of limestone mountains in the district of Gonaives, in the northwestern part of Haiti. It is much larger and more attractive in appearance than the Florida species, having a massive, vase-formed trunk attaining a height of 10 meters or more, leaves and

inflorescences more than 3 meters long, and fruits more than 2 centimeters in diameter. The definite enlargement or bulging of the trunk is analogous to that of several other West Indian palms belong to different genera, *Colpothrinax*, *Roystonea*, *Acrocomia*, and *Aeria*, thus adding another member to this series of parallel evolutions.

Considering that these genera are not related, but belong to distinct families, and that other representatives of these families in the continental areas do not have bulging trunks, the question of a special cause or factor of selection that would favor the development of thickened trunks in the West Indies is naturally suggested. Prevalence of hurricanes in the West Indian region is the most obvious answer, and the greater water-storage capacity of the thickened trunks might be an important advantage in prolonged dry seasons, like that of the present year in Haiti. Two other characters of the new *Pseudophoenix* may be considered as adaptations against drought. The trunk has a very hard outer shell, almost vitreous in texture, and the leaves, inflorescences, and fruits have a heavy coating of wax.

CONFUSION OF THE WINE PALM WITH PSEUDOPHOENIX

The trunk of *Pseudophoenix insignis*, though contracted above the bulge, is not drawn out into a long, slender neck, "in collum longissimum elegantissimum protenditur," as Martius says of *Euterpe vinifera*, the wine-palm of the buccaneers, which Beccari would place under *Pseudophoenix*. The wine-palm seems instead to have been a close relative of the Porto Rican *llume* palm, *Aeria attenuata*, but apparently with the trunk thicker and more bulging, and the fruits larger, as in the related Central American genera *Synechanthus* and *Opsiandra*.

Though the Haitian *Pseudophoenix* is like *Aeria* in having a thickened trunk, the habits of the two palms are quite distinct. In *Aeria* there is a swelling of the basal portion of a tall, slender trunk, while in *Pseudophoenix* the greatest diameter is above the middle of a robust vase-shaped trunk. In *Aeria* the greatest diameter of the trunk is at 3 or 4 meters above the base, in *Pseudophoenix* at 6 or 7 meters. The long, tapering "neck" of *Aeria* may attain a length of 20 meters or more, while the short, cylindrical "neck" of the *Pseudophoenix* is only 1 or 2 meters long, the internodes being very compact. The *Pseudophoenix* is a large palm rather than a tall palm. *Aeria* grows two or three times as high, and justifies the emphatic "alta palma" of Plumier's description.

The alliance of the wine-palm with *Aeria* is indicated not only by the slender prolongation of the trunk, but by the very large, finger-thick roots, the four-foot inflorescence with shining red fruits, the soft, succulent pith from which the juice could be squeezed with the hand, and the spathes that were used as vessels for drawing the palm-wine, according to Plumier's account, as transcribed by Martius. All of the Synechanthaceae have shining red fruits, while the fruits of *Pseudophoenix* do not shine, because they are coated with wax. Also the Synechanthaceae are notable for having the trunk supported by a solid mass of very coarse superficial roots, those of *Aeria attenuata* being about 3 cm. in diameter, or about four times as thick as the roots of *Pseudophoenix insignis.*

It is quite possible, of course, that two or more of the bulging palms were confused in Plumier's notes, but the data that Martius gives in relation to *Euterpe vinifera* are clearly inapplicable to *Pseudophoenix insignis*. Beccari states that there are drawings of *Pseudophoenix* among Plumier's unpublished materials, but the statement of characters shown by the drawings would apply as well or better to *Aeria*, except that the fruits of *Aeria* are not pedicellate, though they have a narrow base that might be represented as a stalk. In any event, the data that Martius extracted from the Plumier collection would determine the application of the name *vinifera*, and these data seem quite definitely to exclude *Pseudophoenix*.

Wendland referred the wine-palm to *Gaussia*, a Cuban genus rather closely related to *Aeria* but having a stout columnar trunk, apparently neither bulged below nor attenuate above. Only one spathe is described for *Gaussia princeps*, and this long and narrow, while *Aeria attenuata* has 7 short, cuplike spathes. As a name for the historical wine-palm the new combination **Aeria vinifera** (Martius) may be used, pending a rediscovery of the palm. This name would replace *Aeria attenuata* if the species should prove to be the same as in Porto Rico, though a somewhat thicker trunk and larger spherical fruits are indicated in the account of *Euterpe vinifera* that Martius gives.[1] With *Gaussia* in Cuba and *Aeria* in Porto Rico it seems reasonable to suppose that the family Synechanthaceae was once represented in Haiti, though the species may be extinct, as Beccari suggests.[2] A palm that yielded a popular beverage might easily be exterminated. Indeed, the abundance of *Pseudophoenix* is evidence that it was not the wine palm. It would not seem reasonable to suppose that such a

[1] Historia Naturalis Palmarum 1: LXXXV.

[2] The Pomona College Journal of Economic Botany, 1912.

use of the palm would have been forgotten among the Haitians, but no knowledge or tradition of wine-making was detected after numerous inquiries.

HABITS OF PSEUDOPHOENIX INSIGNIS

Instead of being confused with *Aeria* or *Gaussia*, the habit and appearance of the Haitian *Pseudophoenix* would cause it to be mistaken for a corozo palm (*Acrocomia*) or a royal palm (*Roystonea*), and this may account for its being so long overlooked. *Roystonea* is the most common palm in adjacent cultivated districts. *Acrocomia* is found in small numbers in the valley between Ennery and St. Michel, but neither of these palms was seen on the dry wind-swept slopes where the *Pseudophoenix* thrives. Hardiness is suggested by the adaptations against drought, already mentioned, and by a notable persistence of the flowers and spathes, which not only remain in place, but are still alive when the fruit ripens. Thus the Haitian palm may prove adapted to cultivation in Florida beyond the range of the royal palm, and possibly also in California, where the royal palm is not known. Seeds have been planted so that a test of the behavior of the new species in the United States is in prospect. It is remarkable that so large a palm growing abundantly in sight of the most commonly traveled roads should have been overlooked by botanical visitors to Haiti, and also that there should be no planted specimens of the palm in Port-au-Prince or in other towns, though several imported palms are grown ornamentally.

Pseudophoenix insignis Cook, sp. nov.

Trunk attaining a height of 10 meters or more, solitary, erect, distinctly bulging or bottle-shaped, narrowed above the base and then gradually thicker, but narrowed again and much more abruptly at a height of 7 or 8 meters; diameter at the roots about 50 cm., at 1 meter above 22 cm., at 7 meters 45 cm., at 8 meters 28 cm., at 8.5 to 10 meters 17 to 18 cm. Internodes of trunk attaining 14 cm. in length near the base, in the bulging portion 5 to 8 cm. and near the top reduced to 1 cm. or less, the lower leaf-scars 1.5 to 2 cm. long, the upper reduced to 0.5 cm., distinctly pitted; the internodes with smooth surfaces at first, then becoming longitudinally rimose, with a very hard brittle outer shell 3 mm. thick, gray on the surface, black inside. Roots 0.7 cm. in diameter, forming a solid black mass at the surface of the ground, breaking away the outer shell of the trunk as in the coconut and other large palms.

Leaf-sheaths 45 cm. long by 15 to 20 cm., the greater diameter of the trunk attained by secondary thickening; surface whitish or grayish green, with a thick coating of wax; petiole 25 cm. long, about 12 cm. wide at base, 6 cm. wide at apex, flat above, distinctly convex below in the middle, slightly concave toward the margins.

Leaf blade 291 to 311 cm. long, rachis 260 to 277 cm., at base 6 cm. wide, at 50 cm. above the base 3 cm. wide, with a shallow median channel 1 cm. wide; the lateral margins of rachis expanded as thin horizontal wings 0.7 to 0.8 cm. wide, forming a deep lateral recess for the insertion of the pinnae; inferior angles of rachis also somewhat prominent, the inferior diameter 2.6 cm., and the lower side convex in the middle; rachis at 1 meter from base 1.5 cm. wide on the upper side and 1 cm. wide below, the upper surface concave with narrow salient margins; rachis at 2 meters narrowed on the upper side to a thin sharp flange 0.8 cm. high and less than 1 mm. thick, the rachis proper 0.7 cm. high and 0.9 cm. wide underneath; rachis beyond 2 meters with the median flange gradually lower and finally disappearing, so that the terminal portion of the rachis is triangular, with the under side becoming distinctly grooved; end of rachis percurrent as a stiff bristle 31 cm. long and about 1 mm. in diameter, slightly exceeding the terminal pinnae.

Pinnae 168 on one side of the rachis; lower pinnae in groups of 3 to 6, the groups 2 to 4 cm. apart with the pinnae 1 cm. or less apart in the groups; groups becoming more widely separated toward the middle of the leaf, and gradually reduced to 2 or 3 pinnae; last 8 or 10 pinnae not grouped, nearly opposite, and lying in the same plane, while the grouped pinnae are inserted at somewhat different angles, though not widely divergent, the upright position being precluded by the horizontal flanges of the rachis; bases of pinnae strongly complicate, the upper and lower margins nearly in contact, with a distinct pulvinus at the upper side, to control divergence from the rachis; lower pinnae reduced to an unusual extent and only gradually attaining full size above the middle of the leaf; lowest pinna 14 cm. by 0.3 cm., second pinna 11 cm. by 0.3 cm., fifth pinna 21 cm. by 0.5 cm., tenth pinna 29 cm. by 0.8 cm., 20th 36 cm. by 1.1 cm., 40th 59 cm. by 1.7 cm., 60th 66 cm. by 2.5 cm., 80th 75 cm. by 2.8 cm., 100th 83 cm. by 2.5 cm., 120th 70 cm. by 2.9 cm., 140th 70 cm. by 2.3 cm., 160th 48 cm. by 1.1 cm., fifth pinna from the end 42 cm. by 0.8 cm., subterminal pinna 34 cm. by 0.5 cm., last pinna 31.5 cm. 0.4 cm.

Inflorescence 315 to 337 cm., the fruiting axis 2 meters from lowest branch to tip, with 65 primary branches; peduncle tough and flexible, strongly fibrous in texture, with 8 joints, the basal joint 30 cm. long, 6.5 cm. wide at base, widened above to 10.5 cm., second joint 16 to 26 cm. long; third joint 35 cm.; fourth joint 12 cm.; fifth to eighth joints 3 to 5 cm. long, together 18 cm.; only the first and second joints with spathes, the others with broad bracts like those subtending the lower branches, the lowest bracts 4 cm. wide, the upper 2 cm.; outer spathe tough, leathery and persistent, remaining alive to the ripening of the fruit or longer, 139 cm. long, 10 cm. wide, strongly compressed, with sharp, thin-margined carinae on each side, the surface with a thick coating of wax, not splitting in the middle but at one side, near the lateral carina, the apex thin and flexible, strongly compressed, gradually narrowed to a blunt tip; second spathe 41 to 47 cm. long, completely included and exceeded by the outer spathe, to the extent of 77 cm., the texture also much thinner and more membranous, the margins narrowly carinate and the surface beset along the margins with large tufted brown scales.

Fruiting axis distinctly flattened at base, 3.5 cm. wide, 2.5 cm. thick; base of branches flattened, 2 cm. wide; lower primary branches 80 to 90 cm. long, with 21 to 27 secondary branches, many of these attaining a length of 20 to 24 cm. and branched again, the 2 to 6 tertiary divisions 12 to 15 cm. long, the lowest primary branch distinctly reduced, 54 cm. long, with 20 secondaries, all simple; second branch 72 cm. long, with 24 secondaries, 5 of these branched; some of the

primary branches with 12 to 15 branched secondaries, but usually the lowest secondary is simple and none of the secondaries are branched above the 12th primary branch; the upper primaries gradually reduced to the simple form, 13 cm. long, the subterminal primaries 7 to 8 cm. long; ultimate divisions of branches subtended by broad, needle-tipped bracts, the first fruit or flower-scar about 1 cm. from the base, the lower scars 3 to 5 mm. apart, the upper closer together, each scar subtended by a minute bract and surrounded by a ring of prominent corneous tissue.

Fruits at maturity rounded above, tapering at the base, 2 to 2.5 cm. in diameter when fresh; double fruits common, 4.3 cm. wide; triple fruits occasional. Pedicels of fruits about 5 mm. long, 3 mm. wide at base, 2 mm. wide in the middle, and 6 mm. wide above, including the broadly angled lobes of the calyx; petals probably increasing in size with the development of the fruits, becoming very tough and horny in texture, remaining alive till the fruit ripens, then changing from a light green to deep brownish color, at maturity nearly 1 cm. long, 0.7 cm. wide; filaments also persistent, about 4 mm. long, 3 opposite the petals and adnate with the petals at base, the 3 alternate filaments free from the petals. Stigmas of single fruit subbasal, persistent, short, divergent, 0.8 to 1 cm. from the insertion of the subtending petal; abortive carpels distinctly prominent, especially on double fruits where the abortive carpel usually has more development than on single fruits, and the stigma may be 1.3 cm. above the petal; triplet fruits with the stigmas central, often persistent in a dry and blackened condition.

Pericarp fleshy, the surface pruinose with a layer of wax, not shining, finely wrinkled when dry, the color changing from green through pale greenish yellow to pink and then to pinkish red, the skin and pulpy layer 2 to 3 mm. thick, with 3 zones easily distinguished before the stage of complete softening is reached, an outer firm layer that becomes red, under this a softer layer at first a transparent greenish color, becoming reddish yellow, and a somewhat firmer inner layer, at first lemon yellow and then orange, closely adherent to the bony endocarp, but easily removed, all the material becoming pulpy, with none of the firm fibers that are a feature in so many palms.

Endocarp nearly spherical, slightly depressed, 1.4 to 1.8 cm. in diameter, smooth, very hard and resilient, of a rather light coffee-brown color, with a firm shell less than half a millimeter in thickness, of very fine-grained, light-colored, horny, columnar tissue, and a membranous lining of nearly the same color as the outer surface, sometimes partly adherent to the seed; hilum nearly 4 mm. wide, appearing as a circular aperture of the bony endocarp, closed with a hard woody material that forms a broadly conic or rounded external prominence pitted at the apex, similar to the hilum of the ivory palms; upper margin of hilum scarcely elevated, forming no distinct tubercle or ad-hilum.

Seed subspherical, slightly depressed, 1.3 to 1.6 cm. in diameter, with a transversely elliptical central cavity 3 to 5 mm. across; surface of seed coated with a furfuraceous but closely adherent thin layer of light brown or tan-colored material overlaying a very smooth thin testa; raphe with two simple flexuous branches on each side, forming shallow grooves of pinkish fibrous material in the tan-colored layer, passing over and around the seed and approaching the embryo, which is indicated on the surface by a slight mammillate prominence to which the light-brown surface coating does not adhere; embryo subbasal, about 5 mm. from the hilum, 4 mm. long, reaching nearly to the central cavity; endosperm hard, with a very fine, uniform, radial structure.

Type in the U. S. National Herbarium, nos. 1,145,487–1,145,492, collected about 3 miles from the locality known as Passe Reine, about 21 kilometers east of Gonaives and 10 kilometers west of Ennery, Haiti, July 28, 1923, by O. F. Cook (no. 28). These specimens are from a single large individual which grew on a slope well covered with the palms. A few of the seeds were planted at Port-au-Prince, August 2, 1923, in the garden of H. P. Davis, and the remainder brought to Washington. The palms appeared most abundant in the district of Gonaives, several miles back from the coast, between Gonaives and Ennery. Others were seen on higher mountains a few miles out of Gonaives toward Dessalines at Savnane Lacroix, and a small number about 20 kilometers north of Port-au-Prince, near the sulphur springs. These are all dry districts, with a rainfall that probably does not average more than 20 inches.

The leaves are used for thatching the roofs of houses. The trunks are split and the sections of the hard outer shell are trimmed down to serve as boards for siding. The fruits are eaten by pigs, and are sometimes gathered for that purpose. The interior of the trunk is of a rather loose pithy texture and sometimes is chewed by the wood cutters to allay thirst, but no other uses of the palm could be learned from the natives. The pith was found to be moist, but coarsely fibrous and tasteless, not sweet and succulent like that of the wine palm described by Plumier. The name *palmiste a vin*, noted by Plumier for the wine palm, was not heard, nor were there any indications that wine was made from the juice of the *Pseudophoenix*. Many of the natives have no name for the palm, or call it *palmiste mal*, to distinguish it from *Roystonea*. The name *caychá*, was learned at Passe Reine, while another informant, from Ennery, said *chacha*.

The name *cacheo* is given by Martius on the authority of Heneken as relating to a palm that grew on dry hills in Santo Domingo, at a place called Guayacanes, a half-day's journey from San Jacobo. This palm is said to have an abrupt spherical enlargement of the trunk at a height of 18 or 20 feet from the ground, the swelling about three times as thick as the trunk. The pith is described as fleshy, soft and sweet, like a melon.

The use of the *Pseudophoenix* for building purposes no doubt would explain why the palms have not survived along the roads or in readily accessible places, but thousands can be seen on rough and craggy slopes, or in sparsely populated districts. The locality near Port-au-Prince is in a district that is distinctly drier than the region behind Gonaives, as indicated by the more stunted vegetation consisting largely of cacti and other spiny plants growing in the crevices of a very rough and jagged limestone formation. As might be expected under such conditions, the trunks of the *Pseudophoenix* appeared to be somewhat shorter, and with shorter internodes and inflorescences, but measurements of leaves showed only slight differences. The foliage is a somewhat darker shade of green than in the royal palm or the corozo, and sometimes with a slightly bluish tone, which may come from the lower surfaces of the pinnae, which are grayish or silvery.

The leaf sheaths are not fibrous, and the upper margins slope backward gradually upward to form the petiole. On old leaves that have shrunken in

drying the petiole and lower part of the rachis are deeply channeled instead of nearly flat as in the living condition. The fallen sheaths are pinkish or salmon-brown inside, while the outside becomes nearly white, on account of the heavy coat of wax. The margins of the sheaths are thin and even, or somewhat torn, but scarcely fibrous, and the texture so firm that the outer leaves remain in place after the sheath has split nearly to the base. In other words, the sheaths are normally more open than in the royal palm, where the leaves would fall if the sheaths were split so far down.

The outer shell of the trunk is extremely hard, almost vitreous in texture, and though longitudinally chinked or rimose on the surface appears very solid as though it were renewed from underneath, like the bark of a dicotyledon. A process of secondary thickening must go on especially in the bulging portion of the trunk, whose diameter is much greater than is ever attained by the terminal bud. To keep the outer shell continuous, while the trunk is enlarging, a continued growth of the shell would be required, and this may be the function of a thin layer of rather soft tissue immediately under the shell.

The waxy coating of the leaf-sheaths, spathes, and other parts may be noted with other indications of relationship of *Pseudophoenix* with the Ceroxylaceae, or wax palms of South America. The structure of the fruit, with a bony endocarp of columnar tissue, and a specialized hilum plugged with woody material, presents analogies with the vegetable ivory palms, which also are natives of South America.

NOTES ON PSEUDOPHOENIX SARGENTII

Measurements given by Sargent[3] show that the Florida *Pseudophoenix* is a much smaller palm. The trunk is 12 to 15 feet tall and 10 to 12 inches in diameter, the leaves 5 to 6 feet long, the largest pinnae 18 inches long and 1 inch wide, the terminal pinnae 6 to 8 inches long and $\frac{1}{3}$ to $\frac{1}{2}$ inches wide, the petiole 6 to 8 inches long, the rachis 1 inch wide, the spadix 3 feet long, the fruits $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter and the seed $\frac{1}{4}$ inch in diameter. The number of pinnae is not stated but the drawing would indicate about 53 each side of the midrib. The drawing of a "branch of a fruiting panicle" shows a greater degree of subdivision than in the Haitian species, since the lower tertiary branches are again divided, with 2 to 6 arms, and the ultimate divisions gradually reduced from 3 cm. to 1 cm. or less, while in *P. insignis* the ultimate divisions are seldom less than 10 cm. and usually are 12 to 15 cm. long.

A series of specimens from Miami, Florida, in the U. S. National Herbarium includes an apparently complete leaf with the blade 150 cm. long, the rachis 130 cm. and the rachis-bristle 18 cm. The upper portion of the rachis has a median flange that remains distinct to the end. The pinnae are about 85 on a side, the lower mostly in groups of two with an occasional single pinna, the lower groups with the pinnae narrow and very close together, the largest

[3] *Silva* 10:33.

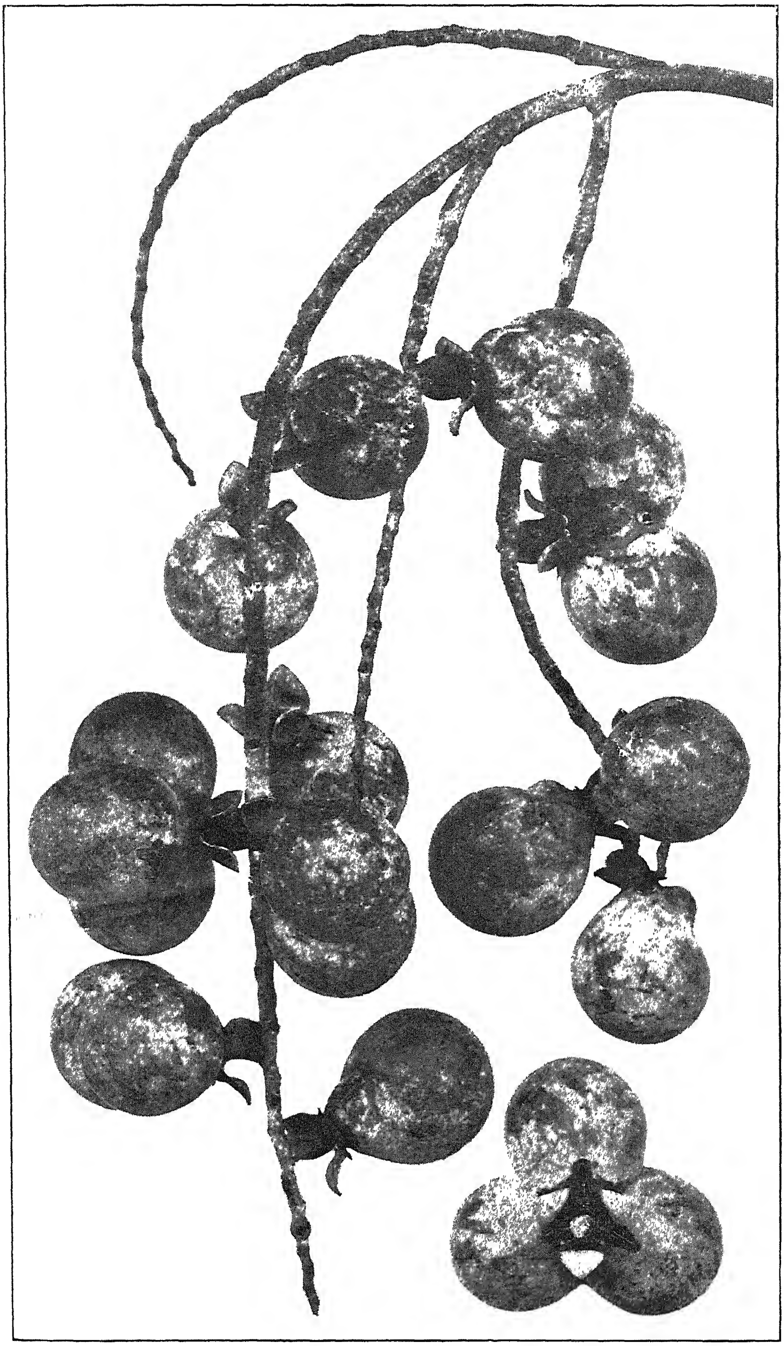

FIG. 1. End of a primary branch of *Pseudophoenix insignis* with mature fruits. Natural size.

pinnae 51 cm. by 2.3 cm. Inflorescence with 33 to 41 primary branches, the peduncle apparently of only 4 joints, the second joint bearing the short inner spathe, which is 10 cm. long by 3 cm. wide, of delicate thin texture, the third joint ending sometimes with a broad bract or in a rudimentary collar-like spathe encircling the peduncle, the fourth joint bearing the first fruiting branch. Outer spathe 3.5 to 4 cm. wide at 20 cm. below the tip, the marginal carinae much narrower than in *P. insignis*, and with brown scales like those of the inner spathe of *P. insignis*.

Thus in addition to the greater size of all the parts in *P. insignis*, there are several other differences, notably the more numerous joints of the peduncle, the greater development of the spathes, the lack of quaternary divisions of the branches of the inflorescence, and three of the filaments adnate below with the inner surfaces of the petals. The reduction of the second spathe to a mere rudiment in *P. sargentii* may be considered as a more specialized character. The basal joints of the peduncle of *P. sargentii* have not been described, and apparently no complete inflorescences have been collected. The unusual development of the first joint, as shown in *P. insignis*, is likely to be a group character, rather than a specific difference.[4]

OTHER SPECIES OF PSEUDOPHOENIX

Study of other specimens of *Pseudophoenix* in the National Herbarium has led to the recognition of two additional West Indian species, one from Cuba, and the other from the island of Saona, at the southeastern extremity of the Dominican Republic. The occurrence of *Pseudophoenix* in these localities has been mentioned by Small, but the plants were not distinguished from *P. sargentii*. Though complete descriptions are not possible, very definite differences are shown by the available material. More attention may be given to the study of this group of palms if characters for distinguishing the species are pointed out.

Pseudophoenix saonae, Cook, sp. nov.

Terminal portion of rachis with no distinct median ridge, the bases of the pinnae decurrent; upper pinnae rather close, irregularly spaced; fifth pinna from the end of the leaf 28 cm. long by 9 mm. wide; subterminal pinna 23 cm. by 7 mm.; terminal pinna 22 cm. by 6 to 9 mm.; terminal bristle 21.5 cm., slightly exceeding 1 mm. in thickness; surfaces of pinnae in the dry specimen uneven, marked with distinct longitudinal ridges and grooves, the veinlets irregular in size, with 2 to 4 veinlets on each side of the midvein much coarser than the others.

Fruits 1.2 cm. in diameter when dry, probably about 1.5 cm. when fresh; filaments robust, broadened gradually to the base, forming a rather thick, distinctly projecting ring; endocarp obovate-globose, 1 cm. in diameter;

[4] A very complete account of the history and distribution of *Pseudophoenix* has been published by Dr. John K. Small under the title *The buccaneer-palm* (Journ. N. Y. Bot. Gard. **23**: 33–43. 1922.)

hilum rounded and prominent, broadly oboval, wider above than below, 4 mm. long, 3 mm. broad, with an abruptly prominent conic-spiniform adhilum about 1 mm. high, distinctly truncate at apex, directed obliquely upward to meet a hardened, sharply triangular columella that projects into the fruit cavity, under the stigma; shell of endocarp somewhat thinner than in *P. insignis* but distinctly thicker than in *P. linearis* or in *P. sargentii;* seed subglobose, nearly 9 mm. in diameter, with a very thin coating of flocculent material, or partially naked, exposing the light chestnut brown testa; impressions of the raphe and its two evenly curved branches very shallow, lined with delicate whitish strands.

Type in the U. S. National Herbarium, no. 758,263, from the banks of a salt lake on Saona Island, Province of Seibo, Santo Domingo, collected December 9, 1909, by N. Taylor (no. 513).

From the proportions and texture of the terminal and subterminal pinnae, as well as from the fruit and seed characters, it is evident that this species is very different from *Pseudophoenix insignis.*

Pseudophoenix linearis Cook, sp. nov.

Petiole at apex probably 1.5 to 2 cm. wide, the rachis narrowed at the lowest group of pinnae; lateral wings of rachis very narrow, only 1 or 2 mm. wide; terminal portion of rachis very slender, less than 2 mm. thick, with a very fine, low median ridge, the upper pinnae rather remote, from 2 to 5 cm. apart.

Lowest pinnae very slender, in a close group of 4 to 6, the bases only 2 to 4 mm. apart, very strongly complicate, with margins thickened and in contact, the margins and the midribs underneath with scattered dark-purplish fibrous scales; first pinna 33 cm. long by 2 mm. wide; second pinna 44 cm. by 5 mm., the apex very slender, remaining adherent 12 cm. from the apex of the third pinna; fifth pinna 72 cm. by 7 mm.; third pinna from end 42 cm. by 6 mm.; subterminal pinna 35 cm. by 4 mm., the terminal subequal or slightly shorter, the rachis-bristle also subequal in length, 1 mm. or less in diameter; pinnae probably glaucous, the margins strongly thickened and the veinlets very close, usually with 2 veinlets on each side distinctly coarser than the others.

Inflorescence with axis attaining about 2 cm. in width near the base, probably distinctly flattened, in the pressed specimen about 7 mm. thick, the branches subtended by persistent and triangular-acuminate bracts, carinate in the middle and distinctly veined; primary branch 35 cm. long, with 18 secondary branches, the base naked for 8 cm.; nine secondary branches with tertiaries, the lowest secondaries largest, attaining 12 cm. with 3 to 4 tertiaries 3 to 5 cm. long; no quaternary branches; the larger simple branches and simple ends of compound branches usually attaining 5 to 6 cm.

Fruits about 1 cm. in diameter; double fruits 1.8 cm.; pedicel slender, 4 mm. long, with an expanded hollow base not attained by the everted petals; calyx rounded triangular, the angles rounded or minutely apiculate; filaments slender, scarcely broadened at the base, inserted on a thin, narrow ring; endocarp obovate, subglobose, 9 mm. in diameter, the wall about half as thick as in *P. insignis*, the hilum oval, the narrow end upward, less than 2 mm. long; margin of the shell above the hilum abruptly prominent, forming a low rounded tubercle (adhilum); seed subglobose, slightly pyriform, 8 mm. in diameter, with the floculent material of the other species mostly replaced by a delicate membrane covering a somewhat thicker and rougher testa, the raphe impressions rather narrow and blackish, the lower branches of the raphe very short.

Type in the U. S. National Herbarium, no. 655,222, collected at Lomo de Loro, Cayo Romano, Camaguey, Cuba, October 21, 1909, by J. A. Shafer (no. 2644). Another Cuban specimen, *Shafer* 2815, collected at Cayo Guajaba, probably represents the same species, and shows a close group of three pinnae that may have come from near the middle of the leaf, these pinnae 64 cm. long by nearly 2 cm. wide. The same sheet has the end of a leaf with subterminal pinnae 34 cm. by 5 mm., and terminal pinnae 28 cm. by 2 mm., with margins closely infolded, and the midvein thickened and prominent beneath; rachis-bristle 28 cm. long, less than 1 mm. wide.

The very narrow pinnae, simple tertiary branches, small fruits, thin endocarp, and small oval hilum may be considered as the diagnostic features of this species. The slender pedicel of the fruits, projecting below the everted petals, is also peculiar. The petals exceed the pedicel in *P. sargentii* and in *P. insignis*, and are about equal in *P. saonae*.

ENTOMOLOGY.—*On the identity of a European chalcidoid parasite of the alfalfa leaf-weevil.* A. B. GAHAN, Bureau of Entomology, U. S. Department of Agriculture. (Communicated by S. A. ROHWER.)

The following note is published at this time for the reason that the European Chalcidoid dealt with is one of those parasites which the United States Department of Agriculture Bureau of Entomology is about to attempt to establish in the state of Utah for the purpose of aiding in the natural control of the destructive alfalfa leaf-weevil *Phytonomus posticus* Gyllenhall.

FAMILY PTEROMALIDAE.

GENUS PERIDESMIA FOERSTER

Type of the genus—Isocyrtus (Trichomalus) aquisgranenis Mayr, by present designation.

The genus *Peridesmia* was described[1] by Foerster, in a table of genera, without included species. The description was apparently based upon the male sex only. Foerster's original specimens afterward came into the possession of G. Mayr and were described[2] by him under the name of *Isocyrtus (Trichomalus) aquisgranensis*. Mayr considered *Trichomalus* Thomson a subgenus of *Isocyrtus* Walker and *Peridesmia* a synonym of *Trichomalus*. His description of *T. aquisgranensis* included both sexes.

Although, strictly speaking, Mayr did not include *aquisgranensis* in *Peridesmia* it is apparent that this species should be considered the genotype of that genus and it is herewith so designated. In order that the type of *Peridesmia* may be definitely fixed the male of Mayr's description is desig-

[1] Hym. Stud. **2**:65. 1856.

[2] Verh. zool.-bot. Ges. Wein. **1903**:394.

nated the holotype of the species, this seeming necessary because there appears to the writer to be a possibility that Mayr has wrongly associated the sexes.

The genera of Pteromalidae are at present in a chaotic condition making it practically impossible, in many instances, to place a species satisfactorily. *Peridesmia* may be truly a synonym of *Trichomalus* as Mayr considered it. Nevertheless the presence in the male of a perfectly smooth area extending from the base of the mandible upward along the posterior eye-margin nearly or quite to the top of the eye, makes the genus readily recognizable in the one sex, at least, and for that reason the name *Peridesmia* is resurrected from the synonymy to cover the species *aquisgranensis* Mayr and the new species described herewith, which are the only two species in which the character is known to occur.

No specimens of the genotype species have been seen by the writer. The generic diagnosis here given is, therefore, drawn from the new species. The characters given by Mayr for both sexes of *aquisgranensis* agree with this diagnosis, in so far as they go, except that the propodeum is said to have a large neck. The new species is practically without a neck on the propodeum in either sex.

The description of the male of *aquisgranensis* agrees so closely with the male of the new species that there can be no doubt that the two are closely related, and the smooth area on the cheek and posterior orbit is such an unusual character in Pteromalidae that I find it difficult to believe that it would occur in two species which differed otherwise by having a large neck on the propodeum in the one case and practically no neck at all in the other. Mayr apparently associated the females with the males on the basis of collected specimens which he found in the Foerster collection pinned with the males but which Foerster seems to have refrained from sending to his correspondents under the name, perhaps because of a doubt as to the correctness of the association. I am of the opinion that Mayr may have drawn his description of the propodeum from a female which was wrongly associated with the male and that the male may be found to lack the neck on the propodeum. Only an examination of Mayr's types can settle this point.

Generic description—Head strongly transverse, wider than the thorax and thin antero-posteriorly; eyes not hairy; occiput concave and immargined; antennae 13-jointed, inserted near middle of head; scape slender, pedicel longer than the first funicle joint, two ring-joints transverse, funicle 6-jointed, club 3-jointed; mandibles both 4-toothed; maxillary palpi 4-jointed; labial palpi 2-jointed; head of the male somewhat thicker antero-posteriorly than in the female, the cheeks slightly swollen with a perfectly smooth area extending from the base of the mandible upward along the posterior eye-margin nearly or quite to the top of the eye; female without such a smooth area; pronotum strongly transverse, perpendicularly truncate in front, the truncature not distinctly margined above, mesoscutum distinctly broader than long, the parapsidal grooves very delicate but traceable for the whole length of mesoscutum; axillae broadly separated; scutellum about as long as mesoscutum and slightly flattened dorsally; propodeum without a neck, punctate, with well

developed lateral folds and a distinct median carina; propodeum laterally, hind coxae above, and sides of the abdomen beneath, distinctly hairy; legs normal, the hind tibiae with one spur; wings fully developed, submarginal vein more than twice as long as marginal, stigmal subequal to marginal, postmarginal slightly longer than marginal; abdomen subpetiolate, as broad as the thorax and about as long as the thorax, elliptical in outline, depressed above and slightly convex beneath, the apices of ovipositor sheaths barely exserted.

Peridesmia phytonomi new species.

If the above conjectures regarding *aquisgranensis* are correct this species may very possibly be a synonym. Aside from the absence of a neck on the propodeum the male apparently differs from Mayr's description only in that the smooth area on the posterior orbit does not extend to the vertex but terminates a little below and behind the top of the eye or a considerable distance from the lateral ocellus.

Female—Length 1.75 to 2 mm. Head with strong close reticulate-punctate sculpture, the punctures on frons somewhat larger than those on vertex and face; clypeus with converging striae; malar space as long as the eye; ocellar triangle very low; postocellar line barely longer than the ocellocular line; antennae weakly clavate; scape reaching to front ocellus; pedicel twice as long as thick at apex; first ring-joint about half as long as the second which is more than twice as broad as long; funicle joints increasing very slightly in thickness from first to last, the first a little broader than long, second subquadrate, sixth a little less than twice as broad as long; club ovate, barely thicker than the sixth funicle joint, about as long as the three preceding funicle joints together, the first and second joints broader than long, apical joint conical and about as long as broad at base; dorsum of thorax sculptured like the head, the punctures on mesoscutum very slightly coarser than those on scutellum; propodeum punctate, a little more strongly so medially that laterally; spiracles elliptical; mesopleura punctate but with a smooth area below the base of hind wing; legs rather slender; hind coxae outwardly reticulate; forewing bare of discal cilia at base, the apex of costal cell with a few cilia, and the surface of wing from a little basad of apex of submarginal vein outwardly to apex of wing rather closely set with short cilia except immediately behind the base of marginal vein where the ciliation is weak and sparse; hind wing sparsely ciliated at base and more strongly so beyond the vestigial basal vein; abdomen polished, the petiole very short; the first segment (not counting the petiole) comprising about one-third the total length; following segments subequal. Head and thorax dull coppery green; antennal scape reddish testaceous basally, shading into dark brown beyond the middle, pedicel and flagellum brownish-black; coxae all concolorous with the thorax, rest of the legs dark reddish testaceous; abdomen above mostly purplish-black but with the base and apex more or less metallic green, the under side concolorous with the thorax but more shining; wings hyaline, the venation dark brown; tegulae testaceous.

Male—Length 1.5 to 1.75 mm. Smooth area on head narrowest at base of mandible, becoming gradually broader on the cheek and broadest behind the eye and terminating at a point on the eye-margin about as far below the vertex as the lateral ocellus is distant from the eye; abdomen shorter than the thorax and about as broad as thorax, elliptical in outline; antennae more slender than in the female, the funicle joints all subequal and subquadrate, the scape entirely testaceous and the pedicel and flagellum brownish testaceous. Otherwise agrees with description of the female.

Type locality—Hyeres, France.
Type—Cat. No. 26537 U. S. N. M.
Host—*Phytonomus posticus* Gyll.
Described from twenty-eight females and forty-two males received from G. I. Reeves of the Bureau of Entomology Laboratory at Salt Lake City, Utah, under Salt Lake Station No. 2745, and reared from material collected at Hyeres, France, by T. R. Chamberlain. Specimens of the species are in the collection of the National Museum also from Milazzo, Sicily.

The species is one of those which the Bureau of Entomology is attempting to introduce into the western states to combat the alfalfa weevil. The female is figured in Bureau of Entomology Bulletin 112, p. 35, Fig. 16, where it is referred to as a Pteromalid egg-parasite of the alfalfa weevil. This figure is acceptable, except in one respect, i.e. the parapsidal grooves are not nearly so well defined as illustrated being traceable on the posterior half of the mesoscutum as very faint lines only.

The larva is said to feed externally on the egg masses of *Phytonomus posticus.*

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE BOTANICAL SOCIETY

164TH MEETING

The 164th meeting of the Botanical Society was held at the Cosmos Club, Jan. 2, 1923, at 8 p.m., with Dr. L. C. CORBETT in the chair, and 66 persons present.

Brief notes and reviews of literature:

Dr. A. S. HITCHCOCK stated that the subject of the National Botanic Garden had been discussed by the Botanical Society of America at the Boston meeting, and that $50.00 had been appropriated to defray expenses of distributing the circular and map of the proposed Garden to members of the Society. The appointment of a member residing in Washington, to act jointly with other societies in the matter, was also authorized.

Program: H. C. SKEELS: *An early-fruiting strain of the chayote,* Chayota edulis *Jacq.* (Illustrated.)

The chayote is a perennial cucurbitaceous vine found from Mexico to Brazil and in the West Indies. The flowers are of two kinds; the pistillate are usually solitary on short peduncles in the axils of the leaves, while the staminate are scattered in sessile clusters on separate inflorescences often a foot long. When both kinds appear at the same node the pistillate flower is open to receive pollen while the staminate inflorescence is still but an inch or two long. By the time this inflorescence bears the first staminate flower ready to shed pollen the pistillate flower has formed a fruit about two inches long.

The chayote fruit is a small solid squash about six inches long, shaped like a pear flattened sideways, or in some varieties nearly spherical, and varying in color from dark green to nearly white. It contains one large flat seed which often starts to sprout before the fruit falls from the vine, but which remains inside the fruit, only the tips of the cotyledons protruding half an inch from the large end and the plumule and radicle developing from between these tips.

Two chayotes were planted at Takoma Park, Md., on May 20, 1922. The first fruit was large enough to use on Oct. 15. On Oct. 28, because of threatening frost, the sixteen largest fruits were picked. The vines, growing on a grape arbor, were covered with canvas, to protect them from frost, until Nov. 25, when a hard freeze stopped most of the growth. At this time the crop consisted of a half bushel of fruits more than 4 inches long and enough smaller ones to fill 3 quart jars; these small fruits were made into pickles.

About the time the first fruit was picked, it was noticed that some of the staminate inflorescences were bearing pistillate flowers. Some of these were examined, and were found to have part of the stigmatic surface changed into another and bearing pollen. Many of these pistillate flowers produced fruits and, hanging in clusters on the long stalks of the staminate inflorescences, formed a marked contrast to the normal fruits which were borne on short peduncles in the axils of the leaves. It is thought that the extra floriferousness was due to heavy rains during the summer washing manure from a chicken yard down onto the level ground in which the chayotes were growing. Chayotes grown at other places in Takoma Park and elsewhere near Washington did not produce any flowers, though the vines made strong growths and were apparently healthy. Considering that possibly these two vines might be developed into an early fruiting strain, one vine was transplanted to the greenhouse at the Bell Plant Introduction Garden, Glendale, Md., while the other is being protected from frost as much as possible where it grew. Ten of the maturest looking fruits have been placed in cold storage at Arlington Farm and will be planted next season. It is interesting to know that two fruits from one of these vines, which have been kept in a moderately cool room, were showing the tips of the cotyledons on Jan. 2, 1923, proving that they are mature enough to grow. As the vine at Bell Station is thriving nicely, the prospects are good for a thorough test of the early fruiting possibilities of this strain.

WILSON POPENOE: *Fruit-growing and ornamental gardening in Chile.* (Illustrated.)

Chile has been called the California of the South. In topography, in climate, and in soil it strongly resembles the Pacific coast region of our own country, and eventually it should vie with California as a producer of fruits such as the peach, the apricot, the pear, the apple, and the prune. For many years Chile obtained such large revenues from the nitrate industry that relatively little attention was devoted to agriculture. Since the end of the World War, nitrate has been at so low a figure that the country has realized the necessity of greater diversification in its resources. One of the first steps taken by the government has been to foster the expansion of commercial fruit growing.

The ornamental plants found in Chilean gardens are, in the majority of cases, ones familiar to Californians. The Lombardy poplar is much used for avenues, and a few native Chilean trees, such as *Maytenus boaria* and *Boldoa fragrans*, are seen in gardens. Various species of *Eucalyptus* and other trees from Australia are commonly grown, and numerous ornamental plants have been introduced from the Mediterranean region. On the whole, it may be said that one familiar with the plants grown in California gardens finds himself altogether at home in Chile.

ROY G. PIERCE, *Recording Secretary.*

JOURNAL

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GEOPHYSICS.—*Density distribution in the Earth.*[1] E. D. WILLIAMSON and L. H. ADAMS, Geophysical Laboratory, Carnegie Institution of Washington.

There are four principal sources of information concerning the interior of the Earth: (1) the constant of gravitation, from which the total mass and average density of the Earth are determined; (2) the constant of precession and other astronomic and geodetic data from which the moments of inertia of the Earth may be calculated, the moment of inertia allowing important inferences to be drawn concerning the density distribution within the Earth; (3) seismologic data from which the elastic constants of the materials in the interior may be computed; and (4) the known flattening of the Earth as determined from the data of geodesy with which any assumed distribution of materials must harmonize. The first three of these sources, together with the values of the elastic constants of various rocks previously obtained by the authors,[2] provide the basis for the present estimate of the density and composition of the Earth at various depths. The bearing of the above classes of data on the constitution of the Earth's interior will first be discussed briefly.

Mean density of the Earth. The constant of gravitation from direct experimental observation is known to be 6.66×10^{-8} cm^3/g-sec^2. This fixes the average density of the Earth at 5.52, and, as is well known, this fact alone allows certain qualitative inferences to be drawn concerning the interior. The density of any ordinary rock is much less than 5.52; therefore in all probability the density near the center must be considerably higher than 5.52 in order to bring the

[1] Received October 19, 1923.

[2] Journ. Franklin Inst. **195**: 475–529. 1923.

mean density of the Earth to the correct value. A number of empirical laws have been suggested for the increase of density with depth. The best known of these is the one proposed by Laplace. According to this the density at any distance r from the Earth's center is given by the equation

$$\rho = \rho_0 \frac{\sin qr}{qr} \tag{1}$$

in which ρ_0 is the density at the center and q is a constant of which the value is fixed by the known total mass of the Earth. Another well-known relation is that of Roche:

$$\rho = \rho_0 (1 - kr^2) \tag{2}$$

in which k is a constant which also can be determined from the total mass or the mean density of the Earth. Either of these formulas, with the usually assumed surface density 2.7, indicates a density at the center somewhat above 10.

The increased density at the center obviously may be due either to the presence of heavier material, presumably iron or nickel-iron, or to a diminution of volume by the tremendous pressure existing at great depths—or both factors may enter. It has often been assumed that the increase of density with depth is merely the result of the compressibility of the homogeneous material, and that the Laplace law, for example, could be used to calculate the compressibility of the Earth at the surface and in the interior. There is no *a priori* reason why this could not be so, but clearly other lines of evidence must be examined before an answer to this question can be secured.

Moment of inertia of the Earth. It is obvious that for a given mass (or for a given mean density) the moment of inertia depends on the distribution of density,[3] e.g. if there is heavy material at the center and light material at the surface the moment of inertia would be considerably less than if the central density were smaller than that of the surface. The moment of inertia itself is not sufficient to fix

[3] The moment of inertia of a sphere with its mass symmetrically distributed about the center is

$$C = \frac{8\pi}{15} \int \rho d(r)^5$$

in which ρ is the density at distance r from the center. For a homogeneous sphere this becomes

$$C = \frac{8\pi}{15} \rho\, r^5 = 0.4\, Mr^2$$

M being the total mass.

the density distribution; it can be used, however, as an important check on a density curve deduced from other considerations. The moment of inertia of the Earth about the polar axis is known to be close to 8.06×10^{44} g-cm². Since the moment about the equatorial axis differs from that about the polar axis by only $\frac{1}{3}$ of 1 per cent, very little error is introduced by dealing with a sphere of radius equal to the mean radius of the Earth and having a moment of inertia equal to the value just mentioned.

The moment of inertia of the Earth if of uniform density from surface to center would be 9.7×10^{44}, significantly higher than the true value. In other terms, the moment of inertia of the earth is that of a homogeneous sphere of density 4.6. From this fact follows the qualitative conclusion that in general the density must increase toward the center, in harmony with the inference already drawn from the high density of the Earth as a whole.

Transmission of earthquake waves. The velocity with which earthquake waves are transmitted through the Earth furnishes important information concerning the interior. It has been shown from the theory of elasticity that any disturbance in a sphere of elastic isotropic material should give rise to various kinds of waves traveling with velocities depending only on the density and elastic constants of the material at each point. Waves of two of these kinds pass through the Earth, while the others, which are less simple to analyze, travel over the surface. A seismograph recording the time of arrival of the various waves at some other point would show the arrival first of the two waves passing *through* the Earth and later that of the various surface ones. One of the "through-waves" consists of transverse vibrations and travels with a velocity

$$v_S = \sqrt{\frac{R}{\rho}} \tag{3}$$

while the other consists of longitudinal vibrations and travels with the higher velocity

$$v_P = \sqrt{\frac{K + \frac{4}{3}R}{\rho}} \tag{4}$$

R being the rigidity and K the bulk modulus. These through-waves should theoretically be easily distinguished from the surface-waves by the circumstance that their apparent velocity (i.e., the velocity

obtained by comparing their times of arrival at various points on the surface with the corresponding distances from the origin) should vary with the distance, whereas the velocity of the surface-waves should be constant. The data obtained from seismograms indicate that the material of the earth, except at the surface, may be treated as (megascopically) isotropic. It is fortunate that this is the case, since otherwise the mathematical treatment of seismologic data would be extremely difficult.

Starting from a time-distance curve, that is, the times of arrival of a disturbance at given distances along the surface, by a comparatively simple process one can calculate the elastic constants of the material of the earth at various depths. The steps in the process are as follows: (a) from the slopes of the time-distance curves the apparent surface velocities of each of the varieties of through-waves is obtained; (b) by graphical integration of a certain function of the surface-velocity there is obtained the maximum depth for a wave traveling between two points separated by a specified distance; (c) from a very simple relation the true velocity at this depth is determined; (d) and finally, the bulk modulus K and the rigidity R are calculated from the equations:

$$R/\rho = v_S^2 \tag{5}$$

$$K/\rho = v_P^2 - \frac{4}{3} v_S^2 \tag{6}$$

obtained directly from (3) and (4).

With the time-distance curve given by Turner[4] the velocity-depth curve shown in Fig. 1 was obtained.[5] In this figure the abscissae represent depth in kilometers and the ordinates the velocity in km/sec. This curve closely resembles that obtained by Wiechert[6] and by Knott.[7] The velocity of both kinds of waves increases rapidly at first, and then steadily and almost linearly until a depth of 1600 km is reached, after which the velocity, although nearly constant, shows a tendency to fall off, especially at about 3000 km. By the use of equations (5) and (6) it is evident that these curves could be converted into a compressibility-depth and a rigidity-depth curve—provided that the density were known.

[4] See Davison, *Manual of Seismology*, p. 145.

[5] Further details will be given in a subsequent communication.

[6] Nachr. Kgl. Ges. Wiss. Göttingen. 1907, pp. 415–549.

[7] Proc. Roy. Soc. Edinburgh, **39**: 167. 1918.

Density change due to compression. We shall next use the above results to determine to what extent the higher density of the interior of the Earth may be due to compression alone. The decrease in volume caused by pressure at great depths can not be calculated from the *measured* compressibility of rocks, even if the pressure were known, because the compressibility decreases with the pressure, which at a depth of only a few hundred kilometers is far beyond the range of laboratory measurement. But, fortunately, the velocity of transmission of earthquake waves yields information as to the variation of compressibility ($1/K$) with depth. The values of K/ρ at various depths were calculated by equation (6), and the results are shown in

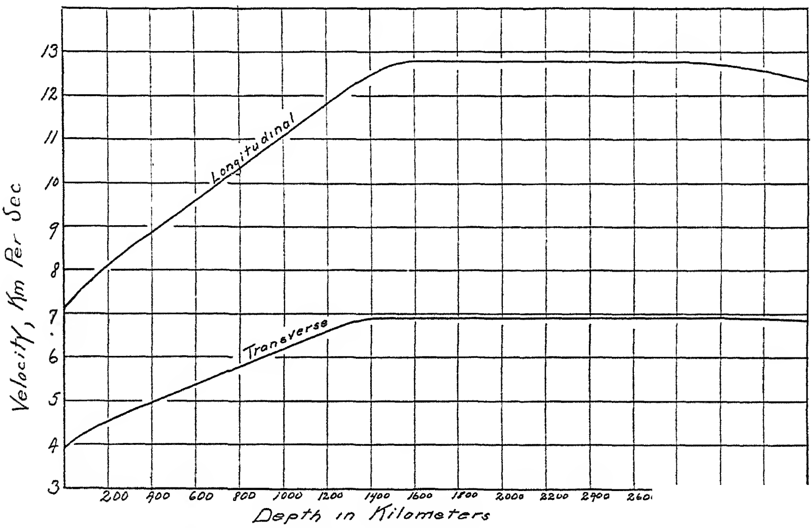

Fig. 1. The velocities of longitudinal and transverse earthquake waves at various depths below the surface of the Earth as calculated from seismologic data.

column 4 of Table 1. Now, it is reasonable to suppose that from this information concerning compressibility it would be possible to determine the aggregate diminution in volume at a given depth on the supposition of a homogeneous earth whose central density is made high by compression and not by a change of composition. We proceed as follows:

In general,

$$\frac{dp}{dr} = -g\rho = -\frac{6.66 \times 10^{-8}\, m\, \rho}{r^2} \tag{7}$$

where g is the acceleration of gravity and p is the pressure at distance r from the center; and m, the mass of the sphere of radius r, is obtained from the relation

$$m = 4\,\pi \int_0^r \rho\, r^2 dr \qquad (8)$$

Now (7) may be written $\frac{dp}{d\rho} \cdot \frac{d\rho}{dr} = -\frac{6.66 \times 10^{-8}\, m\, \rho}{r^2}$

but, on the assumption of homogeneity, $\frac{1}{\rho}\frac{dp}{d\rho} = K$, by definition.

TABLE 1.—FIRST STEP IN CALCULATION OF THE CHANGE OF DENSITY DUE TO PRESSURE AT VARIOUS DEPTHS

r 10^8 CM.	ρ LAPLACE	m 10^{27} GRAM	K/ρ $\left(\frac{\text{CM.}}{\text{SEC.}}\right)^2 \times 10^{12}$	A	$\ln \frac{\rho'}{3}$	ρ'
6.37	3.00	5.98	0.299	2.86	0	3.00
6.00	3.61	5.39	0.446	2.24	0.102	3.32
5.50	4.44	4.56	0.651	1.54	0.191	3.63
5.00	5.27	3.86	0.901	1.14	0.261	3.89
4.50	6.08	2.92	1.001	0.96	0.313	4.10
4.00	6.86	2.18	1.001	0.91	0.359	4.29
3.50	7.58	1.55	1.001	0.84	0.402	4.48
3.00	8.25	1.02	0.890	0.85	0.444	4.68

The values in column 2 are obtained from the equation $\rho = 10.25 \frac{\sin 3.726 \times 10^9 r}{3.727 \times 10^9 r}$

The values in column 3 are obtained by integration of equation 8, using the above value for ρ.

K/ρ in column 4 equals $0.01\ (v_P^2 - \frac{4}{3} v_S^2)$.

A equals $\frac{6.66 \times 10^{-8} m\rho}{r^2K} \times 10^7$ using the values in the previous columns.

The sixth column is obtained from the fifth by integration (see equation 9) and yields the values of ρ' in the last column.

Therefore, by division

$$\frac{d \ln \rho}{dr} = -\frac{6.66 \times 10^{-8}\, m\, \rho}{r^2 K}$$

or

$$\ln \frac{\rho}{\rho_{\bar{r}}} = -\int_{\bar{r}}^{r} \frac{6.66 \times 10^{-8}\, m\, \rho}{r^2 K}\, dr \qquad (9)$$

$\bar{r}$ being the mean radius of the Earth and $\rho_{\bar{r}}$ the surface density.

The density-depth relation is obtained from this equation by approximation and repeated graphical integration. First the density at various levels is assumed (consistent, of course, with the known average density of the Earth). The quantity, r^2, is then plotted against r, and m found by graphical integration of equation (8).

Next, the quantity, $m\rho/r^2K$, is plotted against r, and ρ as a function of r determined according to equation (9) by another graphical integration. This first approximation for ρ is used to calculate a new curve for m, which in turn yields a second approximation for ρ. It turns out that the convergence is very rapid, so that with almost any initially assumed values of the density three successive integrations of equation (9) are sufficient.

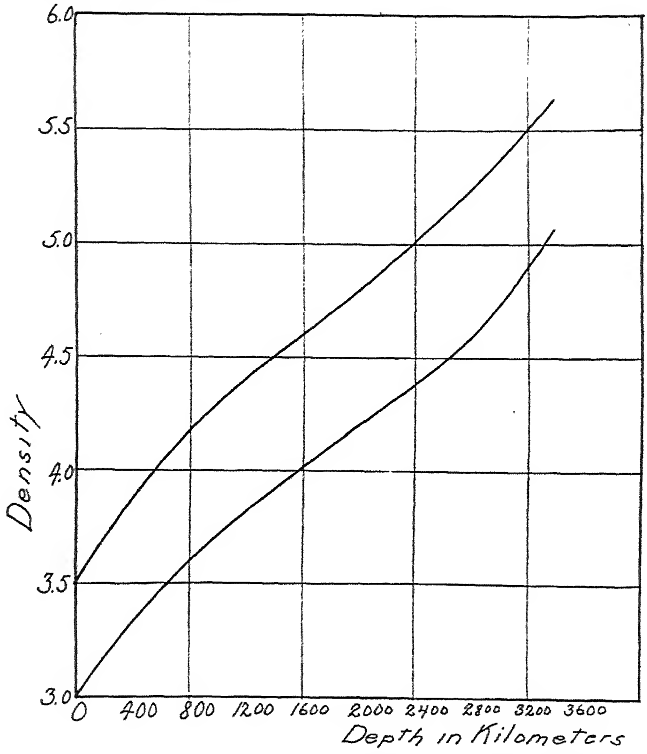

Fig. 2. For two initial densities, 3.0 and 3.5, these curves show the change of density due to compression alone. The values are obtained from the variation of compressibility, which in turn is determined from the earthquake velocity-depth curve.

Table 1 shows the first step of such a calculation, the initially assumed values of ρ being those given by Laplace's equation with a surface density 3.0. From this first step alone it is evident that Laplace's distribution of density is impossible if the condition of homogeneity were fulfilled, i.e. the density according to Laplace increases faster than can be accounted for by compression alone.

The final density curves for two different assumed surface densities (3.0 and 3.5) are shown in Fig. 2. The proper value to take for the

initial density is difficult to determine. It has been placed all the way from 2.7 to 3.7 by various investigators. It is generally agreed that although the average density of surface rocks is from 2.7 to 2.8, corresponding to granite or granodiorite, nevertheless the granitic layer is relatively few miles deep (say 5 to 20); and that underneath this very thin skin of granitic (and sedimentary) rocks lies a more basic material such as gabbro or even pyroxenite or peridotite.

For the moment it will be sufficient to note in Fig. 2 the density curves with two initial densities, 3.0 and 3.5, corresponding respectively to average gabbro and to dense peridotite. Although the calculation was carried only to a depth of 3400 km, this limit being set by the seismologic data, it is clearly evident that the density is not increasing fast enough to make the mean density of the Earth equal to 5.5. For the two assumed surface densities the average density below 3400 km would be 15 and 20 respectively—obviously much too high to be reached by any reasonable extrapolation of the density curves. The high central density demanded by the density curves of Fig. 2 may be considered a consequence of the fact that the core of radius 3000 km has only 1/9 of the volume of the Earth whereas 0.3 to 0.4 of the mass remains to be accounted for.

It is therefore impossible to explain the high density of the Earth on the basis of compressibility alone. The dense interior can not consist of ordinary rocks compressed to a small volume. We must therefore fall back upon the only reasonable alternative, namely, the presence of a heavier material, presumably some metal, which, to judge from its abundance in the Earth's crust, in meteorites, and in the sun, is probably iron. We thus arrive at the conclusion accepted by the majority of geophysicists, but, in addition, we have here (1) a quantitative estimate of the increase of density due to compression alone, and (2) *direct* evidence of the presence in the interior of the Earth of a dense material such as iron.

Effect of temperature. This is a disturbing and uncertain factor. From the known temperature gradient at the surface it follows that the temperature at 100 km depth must be considerably above the melting-point of ordinary rocks; and it seems unlikely that the central temperature can be less than several thousand degrees. The effect of this high temperature on the density is not easily estimated, and might conceivably be very large, but it so happens that the problem is simplified by the fact that at high pressures the expansion coefficient becomes less than at low pressures. Now, the pressure half way down to the center of the Earth is more than a million atmospheres, and

it is not at all improbable that at this pressure the total thermal expansion would be relatively small. For the present, at any rate, we shall ignore the effect of temperature, but with some confidence that in relation to density it is a minor factor.

Previous theories of density distribution in the Earth. Laplace's distribution, already mentioned, should perhaps best be regarded as an empirical relation connecting density with depth, and should not be taken to imply anything concerning the cause of the increased density. The law of Laplace has been criticised because it requires too low a surface density in order to yield the correct value for the moment of inertia. Darwin[8] suggested a different density law with a surface density of 3.7 g. per cc. He held that the sedimentary layer on the outside of the Earth was a mere shell, to be considered separately, and that the density immediately beneath should be taken as the starting point.

Dana[9] in 1873 and Wiechert[10] in 1897 assumed the Earth to be made up of an iron core surrounded by rock. According to Wiechert's[11] later hypothesis the density of the shell is 3.4 and its thickness 1500 km, the density of the core being 8.4. His distribution[12] fits both the mass and moment of inertia of the Earth very well, and the transition point from rock to metal at 1500 km is in fair agreement with the sudden change of direction of the curve of earthquake velocities shown in Fig. 1; but it takes no account of the density due to compression, and fails to explain why there should not be an actual discontinuity at the transition point. At moderate pressures the velocity in basic rocks is notably higher than in iron,[13] and at high pressures this difference will probably increase rather than decrease. Moreover, as may be seen in Fig. 1, the velocity below 1600 km

[8] G. H. Darwin. Proc. Roy. Soc. 1883.

[9] J. D. Dana, *Manual of Geology*. (1873.)

[10] Nachr. Kgl. Ges. Wiss. Göttingen. 1897, p. 221.

[11] Phys. Z. 11: 294. 1910.

[12] It may be noted that on the assumption of a core and a shell each of uniform density the radius and density of the core may be calculated from the known mass and moment of inertia and an assumed outer density by the two equations:

$$\rho_a - \rho_2 = x^3(\rho_1 - \rho_2)$$
$$\rho_m \rho_2 = x^5(\rho_1 - \rho_2)$$

in which ρ_a is the mean density, ρ_m is the density of a homogeneous sphere of moment of inertia equal to that of the Earth, ρ_1 is the density of the core, ρ_2 that of the shell, and x the ratio of the radius of the core to that of the Earth. Thus, if the density of the outer layer is 3.00, its thickness must be 1300 km. and the density of the core is 8.03; and if the outer density is 3.40, the thickness of the shell would be 1600 km. and the central density 8.45.

[13] Adams and Williamson. *Op. cit.*: p. 520.

changes very little—contrary to what might be expected of a *homogeneous* material under a constantly increasing pressure. It may be argued that the effect of temperature in this region may decrease the elastic constants and hence also the velocity. But on any hypothesis the temperature is not increasing rapidly as far down as this, and moreover it seems improbable that increasing temperature would decrease both the rigidity and the bulk modulus by the right amount so that the two velocities would remain so nearly constant.

In recent times Goldschmidt[14] has postulated an arrangement of the matter within the Earth as follows: (1) an outer silicate layer 120 km thick and of density 2.8; (2) a layer of dense silicates (eclogite) extending to 1200 km depth with density varying from 3.6 to 4.0; (3) an intermediate zone of sulfides and oxides of density 5.6 and extending to 2900 km; and (4) a central core of nickel-iron having a density about 8. The average density of this arrangement is very close to the accepted value, and the moment of inertia although 3 per cent too low can be considered in fair agreement. Zoeppritz, Geiger and Gutenberg,[15] and Mohorovičić,[16] and others, have adduced evidence in favor of the existence of various shells or layers in the Earth. For lack of space we can not discuss them here, but will pass on to a statement of the distribution here proposed.

PROPOSED DENSITY DISTRIBUTION

Outermost layer. The average density of the igneous rocks[17] at the surface is about 2.8. Allowing for a small amount of sedimentary rock let us take the surface density as 2.7. The density and basicity of the rocks must increase with depth, the increase being gradual but not necessarily regular. Probably the outer 10 to 20 km has the average composition of a granite or a granodiorite. From the seismographic records of the Oppau explosion Wrinch and Jeffreys[18] found the velocity of the longitudinal waves to be 5.4 km/sec which agrees well with 5.6, the velocity in typical granite at moderate pressures as determined by Adams and Williamson[19] from the elastic constants of the rock. Theoretically the surface velocity can be obtained from the initial slope of the ordinary time-distance curve, but on account of

[14] V. M. Goldschmidt. Z. Elektrochem. **28**: 411. 1922.

[15] Nachr. Kgl. Ges. Wiss. Göttingen. 1912, p. 121.

[16] Beitr. z. Geophysik **13**.

[17] H. S. Washington. Bull. Geol. Soc. Am. **33**: 388. 1922.

[18] Dorothy Wrinch and Harold Jeffreys. Roy. Astr. Soc., M. N., Geophys. Suppl. **1**: 15–22. 1923.

[19] *Op. cit.*, p. 520.

the scarcity of reliable observations for near earthquakes the extrapolation of the surface velocity back to zero distance is unsatisfactory and, moreover, as emphasized by Wrinch and Jeffreys, the usual uncertainty regarding the depth of focus would vitiate the results at short distances. From Turner's table the surface velocity of the longitudinal waves seems to be about 7.1 km/sec—between the values for pyroxenite (7.0) and for peridotite (7.2), and distinctly higher than that for gabbro (6.9). Other seismologists give 8.0 km/sec for the velocity just below the "crust." The seismologic data, although not yielding a satisfactory value for the velocity near the surface, seem clearly to indicate a high velocity at a relatively small depth and thus, in harmony with geological evidence, to imply a preponderance of basic material at something less than 100 km. We propose, somewhat arbitrarily, to take 60 km for the thickness of the layer in which the rocks change from acid to basic. The lower limit of this layer may or may not be identical with the depth of isostatic compensation. From gravity measurements in mountainous regions this depth is placed by Bowie[20] at 96 km, but from the data over the whole United States he places it at 60 km. Washington,[21] moreover, finds the average density of various regions on the Earth to harmonize with the average elevation on the basis of isostatic compensation at a depth of 59 km. In any case this layer has a volume of only a few per cent of the total volume of the Earth and its thickness has little effect on the density distribution of the Earth as a whole. The basaltic substratum, postulated by Daly, Wegener, and others, and of great importance in interpreting the geology of the earth's crust, is here merely an incidental feature in the transition from granitic to ultra-basic material.

Basic Layer. Referring again to Fig. 1, one may note that the earthquake velocity curves run regularly and almost linearly from near the surface to about 1600 km depth. It is natural to assume that this region then is a more or less homogeneous material the bulk modulus and rigidity of which increase regularly with pressure. From reasons given below it is probable that the normal density, i.e. the density at low pressures, of this material is 3.3, which corresponds to 3.35 at a depth of 60 km. The density at other depths may be obtained by interpolation between the two curves of Fig. 2. Thus, at 1600 km depth the density has increased by compression to 4.35.

[20] W. Bowie. U. S. Coast & Geod. Survey, Sp. Publ. No. **40**: 133. 1917.
[21] H. S. Washington. *Op. cit.*, p. 405.

The normal density 3.3 corresponds to a pyroxenite or a peridotite. Throughout this whole region the temperature must be very high, and it is difficult to avoid the conclusion that this layer is all at a temperature above its melting point, its high rigidity being maintained by pressure.[22] Both the density and the earthquake velocity will probably be somewhat smaller in such a glassy material than in a crystalline layer of the same composition, but the difference can hardly be great enough to nullify the evidence in favor of an ultrabasic layer.

It has been suggested that meteorites should have the same average composition as that of the Earth or of any other part of the solar system. Now this average composition[23] (due account being taken of the proportion in which stony and metallic meteorites are seen to fall) corresponds to: olivine, 35; aluminous pyroxene, 42; anorthite, 4; troilite, 5; nickel-iron, 13. The silicate portion is principally an olivine-pyroxene mixture and thus is essentially a peridotite, and should have nearly the same density and compressibility as that postulated for the basic layer.

Pallasite layer. A remarkable feature of the earthquake velocity curves (Fig. 1) is the small amount of change beyond a depth of 1600 km. From compressibility measurements the velocity of the longitudinal waves in iron at moderate pressures is 6.0 km/sec, whereas the velocity in peridotite is 7.2. At high pressures the difference will probably be greater. This circumstance immediately suggests that the nearly constant velocity below 1600 km may be due to a gradually increasing amount of metallic iron mixed with the siliceous rock. The normal tendency for the velocity to increase with depth is thus offset by the admixture, in gradually increasing amount, of iron (or nickel-iron).

The material in this region may be thought of as resembling certain meteorites consisting of a heterogeneous mixture of silicates and metallic iron which is called pallasite. The lower limit of this zone of incomplete segregation is thought to lie at about 3000 km depth where the velocity shows distinct evidence of falling off.

Central metallic core. The remaining part of the Earth consists, beyond reasonable doubt, mainly of iron or nickel-iron with density

[22] Cf. R. A. Daly. *Igneous Rocks and their Origin.* (New York, 1914.) p. 172.

[23] Cf. O. C. Farrington. Field Columbian Museum, Geol. Ser., Vol. 3, Publ. No. **120:** 211–13. 1911.

W. D. Harkins. Journ. Am. Chem. Soc. **39:** 864. 1917.

appropriate to the conditions of pressure (and of temperature) existing in the central region. This density should increase toward the center, but by a relatively small amount.

Now, if we assume (a) that the density in the surface layer varies linearly with depth from 2.7 to some chosen density ρ_s at the top of the basic layer, (b) that in this basic layer the density change can be calculated by interpolation between the two curves of Fig. 2,

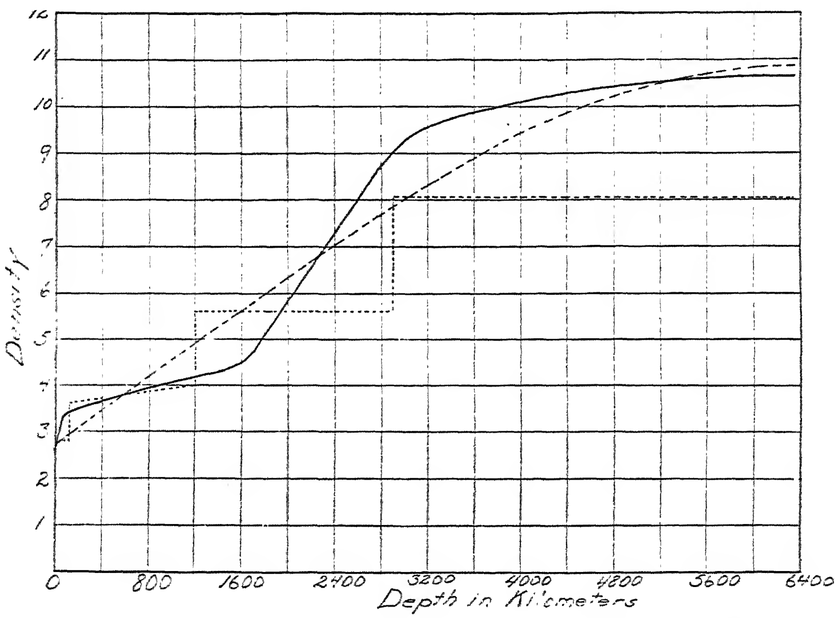

Fig. 3. The density of the Earth at various depths according to the present estimate (full-line curve). For comparison Goldschmidt's distribution (dotted lines), and the density law of Laplace (broken line) are included.

(c) that in the pallasite layer the density changes linearly with depth (the simplest assumption), and (d) that in the central core the density changes parabolically[24] (the simplest assumption compatible with the necessary condition that $d\rho/dr = 0$ at the center), the fact that the distribution must satisfy the known mass and moment of inertia of the whole Earth, allow us to solve two simultaneous equations and find the density distribution in the pallasite layer and in the central core. If this calculation be carried out for various values of ρ_s, it is found that ρ_s must be close to 3.35 in order to yield a reasonable density-variation in the central core. The value 3.45 demands that

[24] That is, according to the relation $\rho = k_1 + k_2r^2$, k_1 and k_2 being constants.

in the core the density *decrease* with depth. On the other hand the value 3.25 leads to an unreasonably high density at the center. For this reason the density at the top of the basic layer has been taken as 3.35, corresponding, as stated above, to a normal density 3.3 and to a density 4.35 at 1600 km. The density of the iron would then be 9.5 at 3000 km and 10.7 at the center.

As a tentative distribution and as a basis for future speculation let us therefore suggest: (1) an outer layer 60 km (about 35 miles) thick in which the material changes more or less gradually from granitic to something more basic than a gabbro; (2) a shell extending to

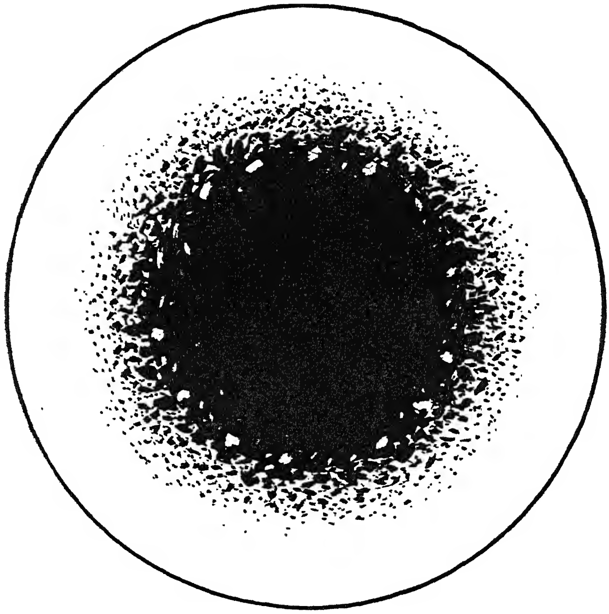

Fig. 4. Diagram intended to suggest the segregation of metallic iron toward the center, and the zone of pallasite (mixture of iron and silicates) surrounding the central core.

a depth of 1600 km, consisting of peridotite, that is, mainly of iron-magnesium silicates and having a normal density 3.3 and a density at 1600 km of 4.35; (3) a shell of pallasite reaching to 3000 km below the surface, in which silicate rock is gradually replaced by metallic iron (or nickel-iron) not yet completely segregated, the density in this shell changing gradually from 4.35 to 9.5; and (4) below this layer of pallasite a central core of nickel-iron of nearly constant density—varying from a little below to a little above 10. The existence of other layers or of other discontinuities is neither affirmed nor

denied. The proposed density distribution merely attempts to harmonize certain known facts regarding the mass and moment of inertia of the Earth, the velocities of earthquake waves, and the compressibilities of rocks.

The distribution here described is shown graphically in Fig. 3 (full-line curve). At the boundary between the various zones the corners are arbitrarily slightly rounded. This diagram also contains, for comparison, a plot of Goldschmidt's distribution (dotted lines), and the density according to Laplace's law (dashed line) with surface density 2.7.

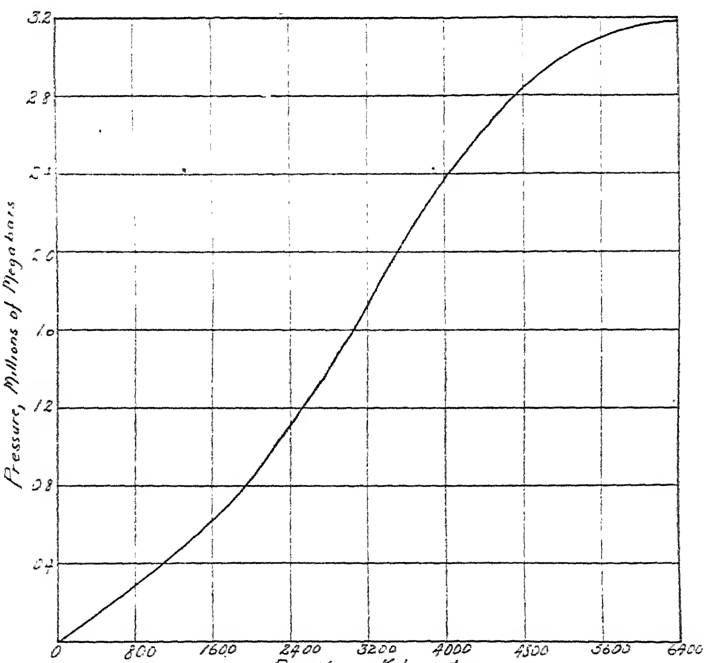

Fig. 5. Pressure as a function of depth, derived from the full-line curve of Fig. 3.

Fig. 4 is intended to illustrate the segregation of iron toward the center and the fringe of pallasite surrounding the iron core. The depth of the surface layer—60 km—is shown to scale by the thickness of the outer circular line.

Pressure in the Earth. The pressures corresponding to the present density distribution were obtained from the equation

$$p = \int^{r} \frac{6.66 \times 10^{-8}\, m\, \rho}{r^2}\, dr$$

by graphical integration, *m* having previously been determined by another graphical integration according to equation (8). The pressures at various depths are plotted in Fig. 5. At the center the pressure is 3.18 millions of megabars, remarkably close to the value obtained from Laplace's law (3.08 million megabars) when the surface density is 2.7.

SUMMARY

For the density and composition of the Earth at various depths there is here proposed a distribution which takes into account the density change due to compression alone. When it is noted that a pressure of 1,000,000 megabars is reached at a depth of less than 2400 km, it is evident that the reduction in volume under such a pressure is a factor not to be neglected. By the use of earthquake data a *quantitative* estimate is given of the density change due to compression of a homogeneous material at various depths—or of that part of the density change due to compression alone in the case of a variable composition. The present distribution, moreover, reconciles the continuity of the velocity depth curves with the difference in velocity in metallic iron and in basic silicate.

Of the four zones described two are sensibly constant in composition but not of constant density (the central core of nickel-iron and the peridotite shell immediately below the surface layer), and two are of variable composition (the surface layer and the pallasite fringe surrounding the metallic core).

The distribution here suggested is at best a rough approximation, but it seems to be the simplest possible arrangement consistent with the physical, seismologic and astronomic data.

In a paper by Gutenberg (Phys. **24**: 296–9. 1923) which has just come to our attention, there is given a density-depth curve which like ours consists of four parts. By assuming the core to be of constant density 2.3 times that of the next layer (also of constant density), Gutenberg calculates that the density of the "Mantel," extending from 60 km to 1200 km depth, varies from $3\frac{1}{2}$ to $4\frac{3}{4}$. This estimate of the density change in the outer parts of the Earth is strikingly like our estimate obtained directly from compressibility and involving assumptions quite different from those of Gutenberg.

BOTANY.—*Note on plants collected in tropical America.* H. PITTIER.

Between October 1887 and the present time, I have collected about 18,000 plants in Mexico, Guatemala, Salvador, Honduras, Costa Rica, Panama, Colombia and Venezuela. These plants have been numbered in two series, and, as the numbers of the one series are

frequently confused with those of the other, a short explanation may be helpful to botanists who have to cite any of them.

The first series was started a few days after my arrival in Costa Rica in October 1887. At that time, I proposed to the Costa Rican Government that it conduct a general survey of the natural products of the country, to be carried on simultaneously with the preparation of a topographic map. The idea was favorably considered and resulted in the organization of the Physico-Geographical Institute of Costa Rica, of which I was director until about 1903, and the decline of which began with my departure for the United States. The Institute as planned was to consist of meteorological, topographical, geological and botanical sections, the first three of which were in my immediate charge. Mr. George K. Cherrie, the well-known American ornithologist and explorer, began his study of tropical birds while connected with both the National Museum and the zoological section of the above-named Institute. The position of botanist was filled by a Swiss, Mr. Ad. Tonduz, who devoted about thirty years of his life to plant collecting in Costa Rica, until his death in the fall of 1921. I myself took an extensive part in the formation of the Costa Rican Herbarium, and from the beginning saw to it that duplicates of the plants were widely distributed between the principal collections of Europe and the United States. I also obtained the collaboration of a large number of plant specialists, whose monographs and enumerations were partly published by the Institute, with the assistance, first of Th. Durand, at the time Director of the Royal Botanical Gardens of Brussels, and later, of the well-known student of the flora of Central America, Captain John Donnell Smith of Baltimore.[1]

Originally it had been intended to distribute these plants through my late friend, the above-mentioned Th. Durand, with whom I had collaborated in the preparation of the *Catalogue de la Flore Vaudoise,* and who certainly succeeded in awakening in me a live interest in the flora of the country in which I had lately established myself. Labels were printed with the heading *Plantae Costaricenses Exsiccatae*, which explains the mention of plants under that designation in some publications. It was soon found, however, that this plan did not work, and after that, the distribution was made directly from San José. New labels were prepared with the heading *Herb. Inst. phys.-geograph. costaric.*, and these were used, not only for the newly collected plants, but also for the whole series, which includes in all about 23,000 num-

[1] See DURAND, TH. et PITTIER, H., *Primitiae Florae Costaricensis* vol. 1, Brussels, 1891–1893; vol. 2 (edited by H. Pittier alone), San José, 1898–1900.

bers. Besides the assistance of Mr. Tonduz, the Institute had the active collaboration of a number of collectors, among whom were the late Prof. Paul Biolley of Neuchâtel, Switzerland, one of the most efficient teachers brought into Costa Rica by the Government of this latter country, Charles Wercklé, an erratic but very keen-eyed botanist, C. Brade, etc., and, among the natives, J. J. Cooper, Anastasio Alfaro, Carlos Brenes, Otón Jimenez, and perhaps a few others. The collecting was continued for several years after I left the country, until the ultimate numbering went up, if I am not mistaken, to about 23,000. Of these, I estimate that about a fourth part was collected by me, half by Tonduz, and the rest by our other co-workers. Of course, every label bears the name of the collector, which fact was the origin of a certain confusion which was increased when I started my own series after I went to Washington. This latter series includes, up to the present date, 11053 numbers, and contains plants from every country of continental America, from Central Mexico to Venezuela, the result of about twenty-two years' explorations.

The most complete set of the Costa Rican collection is probably that of the United States National Herbarium in Washington, which, of course, has also all the plants I brought together while in the service of the United States Department of Agriculture, and the most complete set of my Venezuelan collections.

The botanical exploration of Costa Rica revealed that country as an astonishing center of endemic development for a considerable number of genera and families, and furnished also a large quota of new species. The same can be said of certain parts of Panama, such as the high mountains of Chiriqui and the lowlands of Darien, so that the collection of types of the National Herbarium has been, and is still being, considerably increased by the additions proceeding from these countries.

The plants which form both collections have been, as mentioned above, very often designated so as to cause mistakes and confusion. The first series is that of the *Physico-Geographical Institute*, and the only right way of citing the plants belonging to it is by mentioning this fact. For instance, we would have:

Calathea macrosepala K. Schum.—La Verbena de Alajuelita, near San José, 1000 m., in ditches (*Pittier, Inst. Phys.-geogr. cost.* 8832); near Turrialba, 570 m. (*Tonduz, Inst. Phys.-geogr. cost.* 8310), etc.

Mentioning the first specimen as Pittier no. 8832, as it is done in Schumann's monograph of the *Marantaceae*,[2] is misleading, because the

[2] In ENGLER, *Pflanzenreich*, Heft IV, **48**: 84. 1902.

real *Pittier* no. 8832 in my own series is a *Prestonia*. Unless I am mistaken, Tonduz himself started a new series during the short stay, interrupted by his death, in Guatemala. To continue the erroneous system of numbering the collections in the formation in which I participated, would result, in the end, in thousands of such mistakes, and that is why I have thought it convenient to give the above explanations, which should be put into the hands of all botanists who are interested in the flora of Central America and the northern part of South America.

SCIENTIFIC NOTES AND NEWS

The following resolution was adopted by the Board of Managers of the Washington Academy of Sciences at a meeting held October 29, 1923:

Whereas, The work of scientific men has contributed enormously to the welfare of the human race and especially to the people of the United States of America, and

Whereas, The government of the United States has recognized the importance of scientific investigations and research by the creation of many scientific bureaus, and has appropriated large sums of money for carrying on their work which has been most beneficial to the health, industries, and commerce of this country, and

Whereas, Our people should be kept informed promptly and fully of the progress made and results accomplished by the scientific organizations of the government, and

Whereas, The members of the government engaged on scientific activities can only function to the best advantage by having conferences with scientific men of this country not in government service and with such men of other countries, and

Whereas, This contact can only be gotten by attendance at scientific gatherings in this country and abroad; therefore, be it

Resolved, That the Washington Academy of Sciences hereby petition and urge the President, the heads of departments of the federal government, and the Congress of the United States to give the welfare of science in the United States their earnest consideration and assistance; and to provide by law and by appropriation of the necessary money for the attendance of such scientists of the government as heads of departments may designate at scientific congresses, conventions, and meetings in this country; and for the attendance of such scientists of this country, both in the government and in private life, as may be recommended to the Department of State by competent authority and approved by the head of that Department or the official acting for him, as representatives of the United States of America at international scientific congresses, conventions, and meetings. These appropriations would be exceedingly small as compared with the returns from them in great benefits to scientific advance in America and hence to the promotion of the national welfare.

Be it further resolved, That a copy of these resolutions be sent to the President of the United States, the head of each of the executive departments, the President of the Senate, and the Speaker of the House of Representatives, and that they be published in the Journal of the Washington Academy of Sciences.

Dr. R. B. SOSMAN, of the Geophysical Laboratory, Carnegie Institution of Washington, has been appointed by the National Research Council as American member on the permanent committee for the standardization of physico-chemical symbols of the International Union of Pure and Applied Chemistry. The other members of the committee are: Prof. ERNST COHEN, University of Utrecht, chairman; Prof. ALEXANDER FINDLAY, University of Aberdeen, and Prof. CHARLES MARIE, Sorbonne.

Dr. ARTHUR L. DAY, Director of the Geophysical Laboratory and Chairman of the Carnegie Institution's Advisory Committee in Seismology, gave the opening lecture of the Franklin Institute series for 1923–24 on October 17, 1923. The subject of the lecture was *Earthquakes and volcanic eruptions*.

Dr. HENRY S. GRAVES, dean of the Yale School of Forestry, formerly chief of the United States Forestry Service, has been elected provost of Yale University.

Arrangements have been made with the Radio Corporation of America for a number of short talks on the Smithsonian Institution and its branches to be broadcasted from Station WRC. The first of these talks, on *The Smithsonian Institution, its history and functions*, was given by AUSTIN H. CLARK on October 19. The second, on *The Bureau of American Ethnology; what it is and what it does*, was given by Dr. J. W. Fewkes on October 22. Other subjects are *The Natural History Museum*, *The Arts and Industries Museum*, *The Zoological Park*, *The Astrophysical Observatory*, and *Smithsonian Explorations*. It is estimated by officials of the Radio Corporation that these talks reach an audience of nearly 2,000,000 people, and cover an area 1800 miles in all directions from Washington.

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GEOLOGY.—*The age of the supposed Lower Cretaceous of Alabama.*

EDWARD W. BERRY, The Johns Hopkins University.[1]

A considerable area in eastern Alabama, extending from about the latitude of Montgomery eastward into Georgia was mapped in the 80's and 90's of the last century by the Alabama and Georgia geologists as a part of the Tuscaloosa formation of western central Alabama.[2] Stratigraphically the beds in question, which are predominately sands and clays, lie upon the crystallines, and are unconformably overlain by the sediments of the Eutaw formation.

The physical evidence, admittedly inconclusive, led Clark, Stephenson, and the writer, to tentatively regard them as the continuation of the "Hamburg beds" of South Carolina, the "Cape Fear" formation of North Carolina, and the Patuxent formation of Maryland and Virginia. This opinion seemed to be partially confirmed by the discovery (in 1910 by L. W. Stephenson) of poorly preserved plant fossils in a bluff on the Tallapoosa River, near Old Fort Decatur in Macon County, Alabama. These fossils were submitted to the writer, who, although unable to conclusively determine any of the forms, was led by the presence of certain cycadophyte remains, to express the opinion that the deposit was of Lower Cretaceous age. The presence of numbers of dicotyledonous leaves led to the suggestion that these beds were younger than the Patuxent formation and could scarcely be older than the Patapsco formation of the Maryland-Virginia region.

This opinion was quoted in whole or in part by Clark in 1911[3] and by Stephenson in 1912 and 1914.[4] The writer visited Old Fort

[1] Published by permission of the Director of the U. S. Geological Survey.

[2] LANGDON, D. W., Geol. Soc. Amer. Bull. 2: 587–606. 1890; VEATCH, OTTO, Geol. Survey Georgia Bull., no. 18: 82–106. 1909.

[3] CLARK, W. B., Maryland Geol. Survey Lower Cretaceous pp. 96, 97. 1911.

[4] STEPHENSON, L. W., U. S. Geol. Survey prof. paper 71: 606. 1912; *idem*. 81: 11. 1914.

Decatur in the summer of 1911 without, however, any success in obtaining identifiable fossils. No additional attempt at settling the question was made until the summer of 1923 when Stephenson revisited the locality, and collected a small amount of poor material which was submitted to the writer. Although, as just stated, this material was as badly macerated and poorly preserved as previous collections, it contained one form that appears to be certainly identifiable, and several others that it was found possible to name tentatively.

These indicate that the deposit is Upper and not Lower Cretaceous in age, thus confirming the earlier opinion of the Alabama Geological Survey. This conclusion seems important enough to warrant the present note and to justify the appearance in print of the evidence upon which it is based.

The species positively determined represents Araucarian cone-scales, first discovered in west Greenland, and named *Dammara borealis* by Heer.[5] The Alabama specimens are shown in the accompanying figures 5 and 6. This species has been recorded from a large number of localities in both North America and Europe, but since the various known species of Dammara have very similar cone-scales too much reliance can not be placed upon specific determination. All of the known fossil species of Dammara are, however, Upper Cretaceous in age. In this country *Dammara borealis* has been recorded from the Raritan, Tuscaloosa, Magothy and Black Creek formations, and since all of these occurrences except the first were identified by the present writer, and thus may be presumed to represent the same species of Dammara, their occurrence at Old Fort Decatur points to an age certainly not older and possibly considerably younger than the Cenomanian stage of the European Upper Cretaceous.

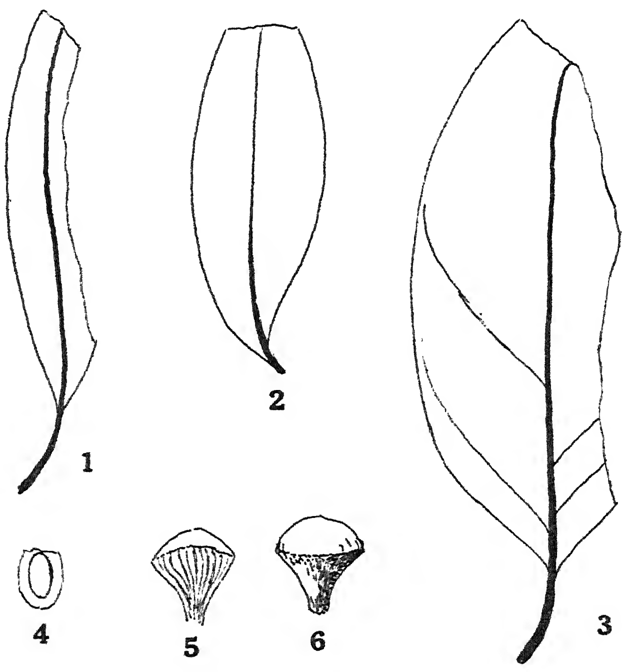
TABLE I

	Tuscaloosa form	Raritan form	Dakota ss.	Magothy form	Black Creek form	Atane beds	Patoot beds	Woodbine sand	Bingen sand	Eutaw form
Cycadinocarpus circularis	X	X			?					
Dammara borealis	X	X		X		X				
Diospyros primaeva	X	X	X	X	X	X	X	X		
Inga cretacea	X		X							
Salix flexuosa	X	X	X	X	X				X	X

[5] Heer, O., Fl. Foss. Arct., **6**: Abt. 2: 54, *pl. 37, fig. 5.* 1882.

As can be seen from the accompanying figures, the balance of the material is very incomplete. The tentative determinations which it has been possible to make are given in the explanation of these figures. The ranges of the species with which the Alabama specimens have been compared may be given briefly in tabular form as follows:

The wide range, and the uncertainty of identification of these forms in the present collection, rob them of any certainty for purposes of precise correlation, but as none of them suggests any late Lower Cretaceous species known to the writer they are entitled to some weight, and as all of them have been found in the known Tuscaloosa formation of Alabama, and as one of the species seems to be positively identified, it would seem that the plant-bearing beds at Old Fort Decatur are of about the age of the Tuscaloosa formation of western central Alabama.



Explanation of Figs. 1–6

1. *Salix flexuosa* Newberry (?). 2. *Inga cf. cretacea* Lesquereux. 3. *Diospyros primaera* Heer (?). 4. *Cycadinocarpus circularis* Newberry (?). 5, 6. *Dammara borealis* Heer.

BOTANY.—*New species of plants from Salvador. II.*[1] PAUL C. STANDLEY, U. S. National Museum.

In the present paper the notes upon two species of grasses have been furnished by Mrs. Agnes Chase, of the U. S. Department of Agriculture, and the description of a new species of *Piper* by Dr. William Trelease of the University of Illinois.

Paspalum botteri (Fourn.) Chase

Dimorphostachys botteri Fourn. Mex. Pl. **2**: 14. 1886. Based on *Botteri* 118, collected at Orizaba, Mexico. The specimen was examined in the Paris Herbarium. This is the species described as *Paspalum macrophyllum* H. B. K. by Nash.[2] The type of that species, also in the Paris Herbarium, was likewise examined, and is found to belong to a different group, not to that of *P. botteri* and its allies (the genus *Dimorphostachys* of Fournier) in which the first glume is developed in at least one of each pair of spikelets. Chase in Hitchcock's Mexican Grasses[3] misapplied the name *Paspalum planifolium* Fourn. to this species. That species is based on a Virlet specimen (without number) from San Luis Potosí, Mexico, and *Müller* 2062 "in herb. Petrop." The Virlet specimen was examined in the Paris Herbarium and is found to be the same as *P. publiflorum* Rupr. *Müller* 2062 in St. Petersburg Herbarium has not been examined. This collection in the Kew Herbarium is *P. lividum* Trin.

SALVADOR: Volcano of San Salvador *Hitchcock* 8956. San Salvador *Calderón* 944.

Syntherisma fiebrigii (Hack.) Chase

Panicum fiebrigii Hack. Rep. Sp. Nov. Fedde **8**: 46. 1910. Based on *Fiebrig* 5371 and 5375 from northern Paraguay, "in herb. Hassler." These two specimens, named in Hackel's script, were examined in the Hassler collection in the herbarium of the Jardin de Botanique, Geneva.

SALVADOR: San Salvador, *Calderón* 1153.

Piper incanum Trelease, sp. nov.

A shrub, 1.5 or in richer soil 3–5 m. high, nodose; flowering internodes moderately slender and short (4×40 mm.), gray-subtomentose; leaves elliptic or subobovate, acuminate, inequilaterally subcordulate, rather small (5–6×12–14 or as much as 8×16 cm.), pinnately nerved from below the middle, the nerves 5 or 6×2, gradually approximated downward, at length bullulate, somewhat thinly appressed-hispid on both faces and gray beneath; petiole rather short (8×2 mm.) and winged at base, or on the more equilaterally truncate-cordulate lower leaves twice as long and winged to or beyond the middle; spikes opposite the leaves, gray-mucronate, in fruit 3×80 mm.; bracts roundish-subpeltate, gray-ciliate; peduncle gray-hairy, 12 mm. long; berries obconic, glabrous; stigmas 3, sessile.

[1] Published by permission of the Secretary of the Smithsonian Institution. The first paper of this series was published in the present volume of the Journal, pp. 363–369.

[2] N. Amer. Fl. **17**: 179. 1909.

[3] Contr. U. S. Nat. Herb. **17**: 234. 1913.

Type in the herbarium of the University of Illinois, collected at San Salvador, Salvador, by Paul C. Standley (no. 19129).

Cuscatlania Standl., gen. nov.

Slender perennial herbs with branched stems; leaves opposite, those of a pair very unequal, the blades entire; flowers in terminal few-flowered leafy-bracted inflorescences, cymose-paniculate, solitary or in pedunculate clusters of 2 or 3, surrounded by an involucre of 4–8 distinct foliaceous bracts; perianth funnelform, corolla-like, purple-red, the tube elongate, scarcely constricted above the ovary, the limb shallowly 5-lobate; stamens 3, the filaments filiform, slightly exserted, inserted upon the perianth tube at its middle, the anthers didymous; ovary oblong, the style filiform, exserted, the stigma capitate; anthocarp oblong-obovoid, constricted at base and apex, almost equally 10-costate.

Type species, *Cuscatlania vulcanicola* Standl.

In general appearance the present plant closely resembles some of the species of *Allionia* and *Mirabilis*, to which it is no doubt related. In those genera, however, the flowers are surrounded by a calyx-like involucre of united bracts. The insertion of the stamens upon the perianth tube is unique in the family Allioniaceae, so far as I am aware.

Cuscatlania vulcanicola Standl., sp. nov.

An ascending or decumbent herb, the slender branches glabrous below, puberulent or villosulous above; petioles slender, mostly 1–1.5 cm. long, glabrous or sparsely puberulent; leaves of a pair very unequal, the smaller less than half the size of the larger ones; larger leaf blades ovate to oblong-ovate or lance-oblong, 5–12 cm. long, 3–4.5 cm. wide, acuminate or long-acuminate, very unequal at base, on one side rounded, on the other acute or acuminate, slightly fleshy, glabrous or nearly so, with numerous and conspicuous raphids on both surfaces; cymes dense, the bracts numerous, leaf-like, 1–2 cm. long, densely viscid-villosulous, short-petiolate, the branches of the inflorescence also densely viscid-villous; flowers sometimes solitary and often in clusters of 2 or 3, the subtending bracts free to the base, 4 to 8, foliaceous, lanceolate or oblanceolate to oblong-elliptic, 10–15 mm. long, acute or acuminate, narrowed at base into a short petiolule, long-ciliate and viscid-villous; perianth about 3 mm. long, the tube very slender, densely viscid-villous with very short hairs, the throat 3–4 mm. in diameter; fruit about 8 mm. long and 3 mm. in diameter, very sparsely and minutely hirtellous.

Type in the U. S. National Herbarium, no. 1,137,438, collected in a quebrada near the base of the Volcán de San Vicente, Departamento de San Vicente, Salvador, altitude about 500 meters, March, 1922, by Paul C. Standley (no. 21678).

The generic name is derived from Cuscatlán, the ancient name of the region which now forms the Republic of El Salvador.

Capparis stenophylla Standl., sp. nov.

Shrub, 1–1.5 m. high, glabrous throughout; leaves mostly clustered near the ends of the branches; petioles very variable in length, often nearly ob-

solete and frequently as much as 7 cm. long, slender; leaf blades narrowly lanceolate to lance-linear, mostly 17–26 cm. long and 1.5–6 cm. wide, acute to long-attenuate at apex, rounded or subcordate at base, lustrous above and with prominulous venation, paler beneath, the venation very prominent, rather thin; flowers subumbellate, on peduncles 2.5–5 cm. long, the pedicels slender, 6–20 mm. long; sepals imbricate in bud, rounded-ovate, obtuse, 2–3 mm. long; petals white, 12 mm. long or more; immature fruit long-stipitate, cylindric, somewhat torulose.

Type in the U. S. National Herbarium, no. 1,137,442, collected in a quebrada near San Vicente, Salvador, altitude about 500 meters, March, 1922, by Paul C. Standley (no. 21681). The following additional specimens have been examined.

SALVADOR: Sonsonate, alt. 220 meters, *Standley* 22330. Sierra de Apaneca, near Finca Colima, Departamento de Ahuachapán, *Standley* 20121.

NICARAGUA: Without definite locality, *Wright*.

Capparis stenophylla may be no more than a narrow-leaved form of *C. baducca* L., a common species of Central America, but the leaves are of so distinctive a form that it seems probable that the Salvadorean shrub merits specific rank.

Sedum salvadorense Standl., sp. nov.

Plants perennial, the stems suffrutescent, about 14 cm. high and 6 mm. thick, granular-papillose above; leaves rather few, alternate, narrowly spatulate-oblanceolate, 2–9 cm. long, 0.5–2 cm. wide, obtuse or rounded at apex, narrowed below into a broad petiole, flat, thin and flaccid, green, the young ones granular-papillose; inflorescence a dense few-flowered cyme about 2 cm. broad, the bracts small, linear or oblanceolate, papillose, the pedicels slender, 2–3 mm. long; sepals linear-oblong, 4–4.5 mm. long, narrowed to a blunt apex; petals white, oblong-ovate, equaling the sepals, cuspidate-acute.

Type in the U. S. National Herbarium, no. 1,136,003, collected on a rock in forest, Finca Colima, Sierra de Apaneca, Departamento de Ahuachapán, Salvador, January, 1922, by Paul C. Standley (no. 20143).

Only a single colony of the plants was found, and the plants were somewhat withered as the result of the long dry season. In spite of their unsatisfactory condition, the specimens seem to represent a species clearly distinct from any heretofore reported from Central America or from Mexico.

Prunus axitliana Standl., sp. nov.

Shrub or tree, 3–7.5 m. high, glabrous throughout, the crown broad and rounded, the young branchlets bright red; petioles slender, 7–11 mm. long, bright red; leaf blades ovate or elliptic-ovate, 5.5–11 cm. long, 2.5–5 cm. wide, obtusely acute or acuminate, rounded to subacute at base, very lustrous on the upper surface, the costa depressed, paler and dull beneath, the slender costa salient, two small round glands present on the lower surface of the blade about 3 mm. above the base; fruiting racemes solitary on young branchlets of the year, stout, about 4 cm. long, few-fruited, the pedicels stout, 6 mm. long; calyx deciduous; fruit subglobose, 10–12 mm. in diameter.

Type in the U. S. National Herbarium, no. 1,152,610, collected on hills near Santa Tecla, Salvador, March, 1923, by Dr. Salvador Calderón (no. 1519). The following sterile specimens obtained by the writer in 1922 also belong here:

SALVADOR: Santa Tecla, alt. about 900 m., *Standley* 23011. Volcán de San Vicente, alt. 1500 m., *Standley* 21515.

Prunus axitliana is related to *P. samydoides* Schlecht., a Mexican species, but is distinguished by its solitary racemes and large leaves. Dr. Calderón reports the vernacular name as *cangrejillo*. The specific name commemorates the King or Topilzín Axitl, founder of the Province of Cuscatlán and of the kingdom Hueytlato or Payaquí, now the Republic of El Salvador.

Acacia calderoni Standl., sp. nov.

A shrub, the branches brown, the young ones densely fulvous-pilose, unarmed; stipules linear-subulate, 5–7 mm. long; petioles 1.5–2 cm. long, without glands, the leaf rachis 5–7 cm. long, densely fulvous-pilose; pinnae 6–9 pairs, mostly 3.5–5.5 cm. long; leaflets about 23 pairs, oblong, 4–6 mm. long, 2 mm. wide, very obtuse, densely covered on both sides, especially beneath, with curved yellowish hairs, the venation obsolete on the upper surface, but both costa and lateral nerves prominent beneath; peduncles axillary or forming a terminal raceme, solitary or geminate, 1–1.5 cm. long, densely pilose; flowers racemose, the racemes very dense, 1.5–2 cm. long, about 1.5 cm. in diameter, the pedicels very short; calyx and corolla 2.5 mm. long, densely pilose with short yellowish hairs.

Type in the U. S. National Herbarium, no. 1,151,942, collected on the Cerro de la Olla, on the Guatemalan frontier near Chalchuapa, Salvador, in 1922 by Dr. Salvador Calderón (no. 977).

Closely related to *A. polypodioides* Standl., a species of southern Mexico and Nicaragua, but easily recognized by the elongate racemes, the flowers of *A. polypodioides* being capitate.

Pithecollobium microstachyum Standl., sp. nov.

Tree, 6–7.5 m. high, the young branchlets slender, puberulent or short-pilose; stipular spines stout, brownish, 1.5 cm. long or less; petioles sometimes 4 cm. long but often much shorter, glabrous, or puberulent, bearing at the apex a stout columnar sessile gland; pinnae one pair, the leaflets also one pair, nearly sessile, oblong to oblong-obovate, mostly 3.5–7 cm. long and 1.5–3 cm. wide, but on flowering branches often not over 1 cm. long, rounded or very obtuse at apex, oblique and obtuse or rounded at base, thick, slightly glabrous but ciliate when young, the venation prominently reticulate on both surfaces; flowers dirty white, in slender spikes 1–3 cm. long, these mostly in ample terminal panicles, the rachis pilosulous, the bracts lance-oblong, shorter than the calyx; calyx sessile, about 1 mm. long, acutely dentate, minutely appressed-pubescent; corolla 3 mm. long, minutely sericeous, the lobes oblong-lanceolate, acute; stamen tube not exserted; fruit several-seeded, short-stipitate, curved or coiled, minutely puberulent or glabrate, the valves thin, red or pink, constricted between the seeds; seeds black and shining, 7–8 mm. long and broad, compressed, surrounded at base by a fleshy white aril.

Type in the U. S. National Herbarium, no. 1,136,477, collected in dry

thicket near La Unión, Salvador, near sea level, February, 1922, by Paul C. Standley (no. 20646). The following additional specimens have been collected:

SALVADOR: Acajutla, *Calderón* 1663; *Standley* 21975.
HONDURAS: Amapala, *Standley* 20744.

It is probable that this is the tree reported from the Gulf of Fonseca by Hemsley as *P. oblongum* Benth. The Salvadorean plant is distinguished from that species by its elongate spikes and very small flowers. The vernacular name employed at La Unión is *mongollano,* a name applied also to *P. dulce* (Roxb.) Benth.

Apalatoa choussyana Standl., sp. nov.

Tree, the branchlets and leaves glabrous; bud scales densely brownish-tomentulose; leaflets 6 or 8, oblong or lance-oblong, 3–6.6 cm. long, 1.5–2 cm. wide, acute or short-acuminate, with blunt tip, unequal at base, cuneate on one side, rounded on the other, thick and firm, lustrous above, paler beneath, the costa subimpressed above, prominent beneath, the lateral nerves not conspicuous; petiolules 2 mm. long, the leaf rachis and petioles together 5–8 cm. long; rachis of the inflorescence and peduncle in fruit 5–9 cm. long, glabrous; fruiting pedicels 4–5 mm. long, stout; legume orbicular or rounded-oval, 5–7 cm. long, 4–5.5 cm. wide, thin, with slightly thickened margin, densely and minutely fulvous-tomentulose, conspicuously rugose.

Type in the U. S. National Herbarium, no. 1,152,621, collected on the Finca San Nicolás, Salvador, May, 1923, by Dr. Salvador Calderón (no. 1573).

At the request of Dr. Calderón this species is named in honor of Mr. Felix Choussy, for many years a resident of Salvador and formerly director of the Escuela de Agronomía, of the Salvadorean government, which was located at Izalco. The vernacular name of the tree is said to be *chichipate.*

Only one species of *Apalatoa* has been reported previously from Central America, **A. Acuminata** (Benth.) Standl.,[4] which was collected by one of the collectors who accompanied the British ship *Sulphur* in its voyage along the western coast of tropical America. The type of this species is said to have come from "Central America," and it is probable that it was collected either at Realejo, Nicaragua, or about the Gulf of Fonseca. The writer has seen no specimens of *A. acuminata,* but according to the description, it differs from *A. choussyana* in its large, abruptly acuminate leaflets, which are widest above the middle. **Apalatoa antillana** (Urban) Standl.[5] also is closely related to the Salvadorean tree, but differs in its larger, thinner, and comparatively narrow leaflets.

Cashalia Standl., gen. nov.

Large unarmed trees; leaves odd-pinnate, the leaflets herbaceous; stipules minute, caducous; flowers racemose, the racemes elongate, many-flowered, simple, the bracts and bractlets caducous; calyx tube broadly campanulate,

[4] *Crudia acuminata* Benth. Bot. Voy. Sulph. 89. 1844.

[5] *Crudia antillana* Urban, Symb. Antill. **6:** 10. 1909.

the limb 5-lobate, the 3 lower lobes triangular-ovate, subequal, the 2 upper ones similar, united for half their length; petal one, rounded-obovate, narrowed below into a broad claw; stamens 10, free, subhypogynous, the filaments slender but broadened below, glabrous, subequal, the anthers oval, uniform, attached near the base, dehiscent by longitudinal slits; ovary short-stipitate, 2-ovulate, attenuate to a slender curved style, the stigma terminal, minute; fruit ovoid or cylindric, 1 or 2-seeded, turgid and subterete, coriaceous, bivalvate; seeds large, ovoid, exarillate, without endosperm, the cotyledons thick and fleshy, the radicle very short, inflexed.

Type species, *Cashalia cuscatlanica* Standl.,

Cashalia cuscatlanica Standl., sp. nov.

A very large deciduous tree, the young branchlets and petioles densely brown-pilose with stiff spreading hairs; leaves petiolate, the rachis 20–35 cm. long, subterete, brown-pilose; leaflets usually 11 or 13, alternate, the petiolules stout, 2.5–6 mm. long, densely pilose, the blades mostly oblong or lance-oblong, usually broadest below the middle but sometimes broadest toward the apex, acuminate or long-acuminate, broadly rounded or subcordate at base, mostly 9–23 cm. long and 2.5–9 cm. wide, the lower ones smaller, thin, bright green on the upper surface and glabrous, beneath paler, densely pilose with short spreading brownish hairs, the lateral nerves 13–19 pairs, nearly straight, extending quite to the margin, the secondary nerves in age prominent and closely reticulate; rachis of the racemes about 30 cm. long, stout, densely brown-tomentose, the pedicels stout, 2–3 mm. long; calyx about 8 mm. long, densely brown-tomentose, the lobes about equaling the tube, obtuse or subacute, tomentose within; standard about 18 mm. long, the blade 15 mm. broad, rounded at apex, tomentose on the outer surface, glabrous within; stamens about 15 mm. long, the anthers scarcely 1 mm. long; ovary densely brown-pilose, the style nearly glabrous; fruit 6–10 cm. long, subterete, acute at base and apex, covered with a very dense and fine, brown tomentum, the stipe very stout, about 6 mm. long; seeds terete-ovoid, 3–4 cm. long, 2 cm. in diameter, pointed at base, rounded at apex.

Type in the U. S. National Herbarium, no. 1,136,051, collected in mountain forest on the Finca Colima, Sierra de Apaneca, Departamento de Ahuachapán, Salvador, January, 1922, by Paul C. Standley (no. 20197). The following additional collections belong here:

SALVADOR: Comasagua, December, 1922, *Calderón* 1379. Hills near Santa Tecla, July, 1923, *Calderón* 1752.

The genus *Cashalia*, a member of the family Fabaceae, appears to be closely related to *Tounatea* (*Swartzia*), the specimens of the Salvadorean tree bearing some superficial resemblance to the curious Brazilian *Swartzia polycarpa* Ducke. In the genus *Tounatea*, so far as can be learned, the stamens are always numerous. Bentham and Hooker state that the ovules also are numerous, but this is improbable since the various species often have one-seeded fruits. The calyx of *Cashalia* is very different from that of *Tounatea*, and there is nothing to indicate that it is closed in anthesis, as it is in the latter genus.

Cashalia cuscatlanica is perhaps the most abundant and probably the largest tree in the primeval forest of the Finca Colima. At the time of the writer's visit to that region, the trees were in flower and nearly devoid of

leaves. The trees were so large that it was impossible to climb them in order to get specimens, but some of the racemes were found upon the ground and leaf specimens were secured from young plants. Dr. Calderón's specimens from Comasagua are sterile, but recently he was so fortunate as to find ample fruiting material on the hills near Santa Tecla, whose flora is similar to that of the Sierra de Apaneca. Dr. Calderón has forwarded a photograph of the tree from which the fruits came, eivdently a gigantic one, which he states was larger than a ceiba, sufficient indication of its size to those who are acquainted with Central American trees. The seeds were found upon the ground, where they were beginning to germinate, their cotyledons at that time being of a deep but brilliant green.

This tree is well known in Salvador, under the vernacular name of *cashal*. It is said to be an important lumber tree.

Amerimnon cuscatlanicum Standl., sp. nov.

Tree, the branchlets and leaves glabrous; stipules oblong-ovate, 10–12 mm. long, obtuse, soon deciduous; leaves somewhat blackened in drying, the petioles and rachis slender, 20–25 cm. long, the petiolules slender, 2.5–4 mm. long; leaflets 13–17, lance-oblong or the lowest ovate, 6–10 cm. long and 2–2.5 cm. wide, the lower ones smaller, slightly narrowed to the obtuse apex, rounded to subacute at base, thin, bright green above, the venation prominently reticulate, much paler beneath, the venation prominent and finely reticulate; racemes numerous, forming a dense panicle about 8 cm. long on old wood, the bracts similar to the stipules, ciliate, the branches densely brown-pilosulous, the bractlets minute, oblong, densely pilosulous; flowers white, about 16 mm. long; calyx 4–5 mm. long, densely brown-pilosulous, the lobes about equaling the tube, oblong-ovate, obtuse, the carinal lobe much longer and narrower than the others; petals glabrous, the standard short-clawed, the blade suborbicular, 12 mm. long, rounded at base, obscurely retuse at apex, the wings obovate, oblique, rounded at apex, nearly 10 mm. long.

Type in the U. S. National Herbarium, no. 1,152,618, collected at San Salvador, Salvador, in 1923, by Dr. Salvador Calderón (no. 1557). Sterile specimens which probably represent the same species were collected at Comasagua in December, 1922, by Dr. Calderón (no. 1555).

The Salvadorean tree is related to **Amerimnon lineatum** (Pittier) Standl.[6] and **A. retusum** (Hemsl.) Standl.,[7] of Costa Rica and Panama, but differs from both in its perfectly glabrous leaflets, which are also more numerous and narrower. The vernacular name is *funera*. The wood is highly valued for cabinet work and for general construction purposes.

Amerimnon lineatum, described from the Nicoya Peninsula of Costa Rica, also has been collected at San Salvador, where it bears the name of *funera*. Dr. Calderón states that the trees of *A. cuscatlanicum* are leafless during the dry season, but that in the middle of March the young leaves and flowers are produced, the flowers, however, lasting only two or three days. The stipules are conspicuous upon the very young branches, but quickly fall.

[6] *Dalbergia lineata* Pittier, Journ. Washington Acad. Sci. **12**: 63. 1922.

[7] *Dalbergia retusa* Hemsl. Diag. Pl. Mex. 8. 1878.

The specific name is derived from Cuscatlán, the aborginal name of the Valley of San Salvador and of its principal city.

Amerimnon melanocardium (Pittier) Standl.

Dalbergia melanocardium Pittier, Journ. Washington Acad. Sci. **12**: 57. 1922.

The type of this species was collected in the Department of Santa Rosa, Guatemala. It has been recollected recently at Santa Tecla, Salvador, by Dr. Salvador Calderón (no. 1517), who reports the vernacular name as *chapulaltapa*, a name applied in Salvador to several leguminous trees of various genera.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

176TH MEETING

The 176th meeting of the ACADEMY was held jointly with the Geological Society of Washington, the Biological Society of Washington, and the Botanical Society of Washington in the Auditorium of the Interior Building, the evening of Wednesday, March 14, 1923. The evening was devoted to a symposium upon *The fossil swamp deposit at the Walker Hotel site*, Connecticut Avenue and De Sales Street, Washington, D. C. The program was as follows:

C. K. WENTWORTH. *The geologic relations.* (Read with supplemental remarks by L. W. STEPHENSON.)

E. BROWN, Department of Agriculture. *Seeds and other plant remains.* (Presented by FREDERICK V. COVILLE.)

E. W. BERRY, Johns Hopkins University. *The plant remains and their significance.*

ALBERT MANN, Carnegie Institution. *The remarkable fresh water diatom flora from the swamp deposit, and its significance.*

LAURENCE LA FORGE. *The physiographic relations of the swamp deposit.*

These addresses will be published in full in the JOURNAL of the Washington Academy of Sciences.

177TH MEETING

The 177th meeting of the ACADEMY was held jointly with the Philosophical Society of Washington, the Washington Society of Engineers, and the American Society for Steel Treating, in the Auditorium of the Interior Building, the evening of Saturday, March 31, 1923. Dr. WALTER ROSENHAIN, F. R. S., of the National Physical Laboratory, England, delivered an address entitled, *The structure and constitution of alloys.*

Dr. ROSENHAIN discussed the general theory of the constitution of ferrous and non-ferrous alloys, the construction of constitutional diagrams which represent graphically the transformations that occur in a metal or an alloy on cooling or heating, their interpretation and relation to the physical properties of alloys. Lantern slides of typical constitutional diagrams were shown and discussed. The question of laboratory equipment for the study of the structure and physical properties of alloys was next considered, and many interesting photographs and diagrams were shown of apparatus developed

by Dr. Rosenhain and his collegaues at the National Physical Laboratories. These included special microscopes, heating and quenching furnaces, special furnaces for the determination of thermal transformations and high temperature thermostats. The latter are used for the heating of alloy specimens for a period of several weeks or months at a constant temperature which has been proved necessary to obtain equilibrium conditions. The development of this thermostat has made possible the determination of the constitutional relation of certain alloys in which the phase changes take place very slowly and about which there has consequently been considerable doubt.

Dr. Rosenhain also discussed briefly the organization of the department of metallurgy at the National Physical Laboratories and some of their problems, particularly their work on the ternary diagrams of the light aluminum alloys.

178th meeting

The 178th meeting of the Academy was held jointly with the Philosophical Society of Washington and the Chemical Society of Washington in the Auditorium of the Interior Building, the evening of Tuesday, April 17, 1923. Dr. James C. Irvine, Principal and Vice-Chancellor, University of St. Andrews, and Dr. F. G. Donnan, Professor of Chemistry, University College, London, addressed the Societies concerning their own recent researches in chemistry.

Principal Irvine spoke on researches on *The constitutional formula of starch.* The first step was to determine the constitution of maltose, and this proved amenable to a method already developed by the speaker in which glucosides and complex carbohydrates are methylated before hydrolysis. Determination of the constitution of the scissive products thus obtained shows how the constituents of the complex molecule have been combined. By this method the maltose molecule was shown to be formed from two glucose residues by junction at the ends of the carbon chain. A similar process carried out on starch showed that two-thirds of the products corresponded with those obtained from maltose, but the remaining one-third showed that a third molecule of glucose goes to make up the unit molecule of starch and that it is attached in the manner characteristic of cellulose. The simplest possible unit for starch is therefore one containing the nuclei of three molecules of glucose, two attached as in maltose and the third as mentioned above. An objection to this is that some experimenters have claimed a larger yield of maltose than the 72 per cent which would result from starch of this structure. These yields, however, refer to material which does not behave as a chemical individual towards bacteriological tests, and the most careful experimenters have declared that the maximum yield of the pure substance is about 70 per cent.

Professor Donnan discussed *Membrane equilibrium.* He dealt with a number of cases of solutions separated by membranes which are impermeable to certain of the ions. The exact equations for the relative concentrations can be obtained by Gibbs' method of equating the μ-function for the ions which can pass the division. Approximate results may be obtained by using the usual dilute solution formula for the μ-function. These approximations agree fairly closely with the results of a large number of experiments on solutions of various salts separated by ferrocyanide and other membranes. The predicted differences in e.m.f. across the membrane also agree fairly well with the facts.

179TH MEETING

The 179th meeting of the ACADEMY was held jointly with the Geological Society of Washington and the Philosophical Society of Washington in the Auditorium of the Interior Building, the evening of Wednesday, April 18, 1923. The program consisted of three addresses dealing with *The Taylor-Wegener hypothesis.*

The first paper, by FRANK B. TAYLOR, was entitled, *The lateral migration of land masses.*

One of the most remarkable things on the Earth is the great belt of Tertiary fold-mountains which forms a nearly complete girdle around the globe. It is believed that the distribution of this belt and certain other well defined characteristics associated with it furnish the key to the nature of the cause which made it. These mountains form a folded and faulted margin along the entire southern front of the continent of Eurasia; then passing over into North America through the arc of the Aleutian Islands, which in reality belongs to the Asiatic structure, the belt turns southward and forms the Cordilleran ranges through the entire length of the two Americas. From the East Indies a branch extends eastward and southward around the north and east sides of Australia to New Zealand, but shows only as chains of volcanic islands. The ranges of the entire belt are all of substantially one age; they were all either greatly augmented or made outright in the Tertiary age.

The salient facts are these, and they have a profound bearing on the nature of the cause: (1) The Tertiary ranges which lie along the southern margin of Eurasia show many times the strength of those parts which are related to the two Americas and to Australia, and this applies to all of the phenomena associated with them—to the arcuate expression of the ranges and the larger earth-lobes, to the rifts in high latitudes, and to the narrow foredeeps. (2) Although the development of subsidiary arcs in the two Americas is much weaker than in Asia, it is much stronger than that associated with Australia, where no subsidiary arc-forms are recognizable. (3) The cause, whatever its nature, is clearly and strongly related to latitude. The continental crust-sheets of Eurasia and North America migrated in southerly directions, while at the same time those of South America and Australia moved in northerly directions. All of the masses that moved migrated from high latitudes toward low latitudes, as though impelled by a force which tended to increase slightly the oblateness of the Earth's figure. (4) The Tertiary mountain belt mapped on Mercator's projection does not give a true idea of the relation of the crustal sheet of Eurasia and its marginal mountain belt. On a north-polar projection, or better on the land-hemisphere, one sees that from the Canary Islands to the mountain angle in Alaska is about 230° of longitude, or considerably more than half-way around the globe. The striking uniformity of strength through this whole distance is strong proof that it was the continental crust-sheet which moved southward in forming the mountains, rather than the sinking and landward thrusting of oceanic segments, an idea which would require India and Africa to be counted with the sinking masses, whereas Suess says that India and Africa remained unmoved during the Tertiary mountain-making. Many separate segments would necessarily be involved, but to produce the observed uniform result they must all act with about equal strength, and with markedly

greater strength than those segments which affected the two Americas and Australia.[1]

In the opinion of the writer the movements of the continental land masses in the Tertiary mountain-making are not in accord with any form of contraction hypothesis, neither with that derived from Laplace, nor Chamberlin, nor Wegener, but are in perfect accord with the action of a tidal force. The present tidal force exerted by the Moon upon the Earth is calculated to be equal to about 1/1,000,000th of gravity—too small, apparently, to be regarded as competent. The problem, then, is to find a competent tidal force.

For many years the writer has entertained a theory of direct capture for the origin of satellites, including, of course, the Moon. The event of the Moon's capture toward the close of the Cretaceous period, and its retention as a permanent satellite of the Earth, furnishes the circumstance and a competent agency for the production of the necessary tidal force. The following considerations are believed to afford adequate support for this claim.

"The tide-producing force of a body varies inversely as the cube of its distance and directly as its mass." (Young's Manual, 1912, p. 303). The Moon's present mean distance is in round numbers 240,000 miles. At half this distance the tide-producing force would be 8 times as strong. At 1/10th or 24,000 miles it would be 1000 times as strong. At 1/20th or 12,000 miles it would be 8000 times as stong. The present tidal force is equal to about 1/1,000,000th of gravity. At 24,000 miles it would be 1/1,000th of gravity, and at 12,000 miles 1/125th of gravity.

The eccentricity of the Moon's present orbit is 0.0549, or nearly twice that of any other large satellite. The first fourteen of the short-period comets in Young's table (p. 586) have eccentricities ranging from 0.40 to 0.84. If the Moon was acquired by direct capture, as here postulated, its eccentricity must have been much greater at first than it is now. In the absence of direct knowledge, it seems reasonable to assume that the Moon's eccentricity at the time of capture was of about the same order of magnitude as those of the short-period comets or something between, say, 0.50 and 0.90. Thus, when the Moon was first captured, the tidal force was, in all probability, something between 500 and 3000 times as strong as it is now. With the Moon's perigee 24,000 miles from the Earth, the tidal force would be 1000 times greater than it is now, and this is certainly a conservative assumption for the Moon's eccentricity at that time, and for its distance at perigee. Since capture, the reduction of eccentricity has, of course, been extremely slow, capture having taken place at least two or three millions and perhaps four or five millions of years ago.

At the present time earthquakes show well marked maxima and minima corresponding to the Moon's nearest and farthest distances from the Earth respectively. This effect is intimately responsive to the varying power of the tidal force, and with increasing degrees of eccentricity and decreasing distance of perigee it would be rapidly increased under the law stated above. The maximum tidal force would, of course, act for only a few days in each month, but it would be very powerful and fully competent, in the writer's opinion, to produce the observed results. It would tend to increase by a small amount the oblateness of the Earth, and would by so much increase,

[1] In a paper entitled *Bearing of the Tertiary Mountain Belt on the origin of the Earth's plan* (Bull. G. S. A., **21**: 179-226. 1910) the writer discusses these and other points more fully.

in effect, the altitude of all lands in high latitudes. It would also exert a powerful force tending to cause high-standing crustal masses in high and middle latitudes to creep away toward low latitudes, leaving rifts near the poles, and causing folding, faulting, and uplifting, with narrow outside fore-deeps in a marginal belt toward the equator, precisely as is so well exemplified in the distribution and characteristics of the great Tertiary mountain belt. To accomplish this, the Earth, in the writer's opinion, must be supposed to have a solid, rigid central body, viscous to prolonged stress in a film next beneath the zone of fracture.

The crustal movements and mountain-making of the earlier geologic periods are not related in any way to the Moon's tidal force, for the Moon had not then been captured. They are, in all probability, related to the solar tidal force which was much more powerful in its action on the Earth, when the Earth was nearer to the Sun. (*Author's abstract.*)

A critical review of the Taylor-Wegener hypothesis was next presented by Prof. REGINALD A. DALY, Harvard University.

According to Pepper's *Playbook of metals*, published in 1861, the suggestion that continents have migrated through long distances had already been clearly expressed by M. A. Snider. The idea was adopted by O. Fisher in his *Physics of the Earth's crust* (1889), and has been greatly elaborated by F. B. Taylor (1910) and A. Wegener (1912–1922). The general grounds for the hypothesis include: many topographic, structural, and biological (paleontological) correspondences among the continents; the difficulties of land-bridge theory; the difficulties facing other theories of crustal deformation; and the asymmetry, arcuate plans, of mountain chains. The following abstract relates especially to Wegener's statement.

Wegener assumes (1) that essentially all of the Paleozoic land formed one continent, which had been derived from a universal salic shell of the primitive earth; (2) the flotation of this unique continent in a practically fluid, basaltic shell (the *Sima*), which also floors the whole ocean; (3) the existence of a force sufficient to cause a drift of continental blocks toward the equator (the *Polflucht*); (4) the existence of a force sufficient to move each continent to the westward (*Westwanderung*); and (5) the spasmodic displacement of the earth's axis of rotation with reference to the crust, and that through many tens of degrees.

He concludes that the *Polflucht* force caused the east-west mountain chains of the Paleozoic, Mesozoic, and Cenozoic eras. During the Mesozoic the great continent was broken into large fragments which then, and at intervals until the present day, drifted, and either separated, with the formation of the Arctic, Atlantic, and Indian oceans, or collided, with the development of mountain ranges in the loci of collision. He explains all islands as fundamentally salic, representing the smaller fragments; the arcuate mountain ranges of eastern Asia are fragments left behind during the westward migration of Eurasia. With these exceptions all mountain chains are attributed to the downstream pressures exerted by moving continental blocks. Taylor had adopted the same conclusion but made no exception of the east-Asiatic arcs, whose asymmetrical but systematic plan prompted his statement of 1910.

Wegener's assumption of practically no strength in the sub-oceanic crust, the salic, continental part having notable strength, is basal to his whole reasoning and yet appears to be quite indefensible. Believing the *Sima*, cold or hot, to be essentially fluid, he could permit himself to think that

rotational and tidal forces are adequate to cause the *Polflucht* and *Westwanderung* of floating continents. Lambert, Epstein, and Schweydar have proved the insignificance of these forces.

Wegener lays down as a principle that, during the westward migration, the larger continental blocks should outstrip the smaller. Yet he considers the less massive Americas to have moved faster than Eurasia-Africa, which was also left behind by the long but narrow fragment represented in the mid-Atlantic swell. This is but one of several inconsistencies in his reasoning.

His speculation regarding extensive wanderings of the poles encounters both geophysical and geological difficulties. With the earth's axis in the positions given in the third edition of his book, one has trouble in accounting for many facts, including: the Mesozoic coals of South Africa and the Cretaceous coals of British Columbia; the persistence of the Tethys and correlated lands; and the postulated movement of India (which actually had to climb the *Polflucht* slope). Wegener assumes peninsular India to have been endowed with energy out of all proportion to its mass, but offers no reason for the peculiarity of this particular fragment of the Paleozoic continent.

Wegener's presentation of the case has provoked much discussion and many objections, in addition to those listed. So obvious are his logical inconsequences and his failure properly to weigh ascertained facts that there is danger of a too speedy rejection of the main idea involved. The question remains whether a better statement of the hypothesis can be made in terms of: (1) considerable strength of the suboceanic crust as well as of the continental part of the crust; (2) a density of the suboceanic crust greater than the density of the basaltic shell (substratum) immediately beneath it, involving one cause of crustal instability; (3) possibly a similar, though smaller, contrast of densities in the case of the continental part of the crust and its basaltic substratum; (4) the elastico-viscosity of the basaltic substratum, rigidity and time of relaxation increasing to a depth of about one-half of the earth's radius; (5) deleveling of the continental part of the crust through a combination of oceanic pressure, the earth's contraction, secular denudation, differential radioactivity, secular dimunition of the earth's rotational velocity (the axis fixed), and the temporary deformation of the geoid because of overthrusting. Such deleveling gives a second condition for instability. When the amplitudes of the crustal inequalities became large enough, a break-up of the Paleozoic continent and the sliding of the fragments were compelled. The sliding is expected to have been directed toward the central Pacific, on all sides of that basin, and also directed in the sense of the meridian. (See two articles in the American Journal of Science, May, 1923.)

Whether or not this sliding hypothesis can be shown to be more valid than Wegener's drift hypothesis, geologists have good reason to retain the root idea embodied in the writings of Fisher, Taylor, and Wegener. (*Author's abstract.*)

The concluding address, by W. D. LAMBERT, of the United States Coast and Geodetic Survey, was entitled, *The mechanics of the Taylor-Wegener hypothesis of continental migration.*

The amount of published matter dealing with Wegener's development of the hypothesis of continental migration so greatly exceeds that dealing with Taylor's presentation, in spite of the latter's priority of publication, that this discussion necessarily deals with Wegener's form of the theory rather than with Taylor's.

The hypothesis of large displacements of the earth's axis of rotation in the body of the earth (or of the poles on the surface) forms part of Wegener's scheme, although it is not a necessary corollary of the assumption of continental migration. In general, large displacements of the pole, apart from oscillations of short period, imply extensive rearrangements of mass within or upon the earth, rearrangements too large for geologists to accept. On Wegener's scheme of continental blocks of "sial" floating in "sima" even the shifting of a large continental block over many degrees of great circle would involve such a small *effective* rearrangement of mass that the resultant displacement of the pole would be unimportant. Wegener cites two articles as tending to show that large displacements of the pole might take place without correspondingly large rearrangements of mass; one citation is based on a misapplication of the words quoted; the other article cited involves fundamental fallacies in mechanics.

If the earth were a rigid spheroid, an increase in its speed of rotation or in the tide-producing action of a satellite would tend to move a particle on its surface toward the equator. This idea has been invoked as a possible explanation of the equatorward drift of the continents. But the continents are not particles but masses of matter forming part of a continuous crust and therefore impeded in their motion by their surroundings; furthermore, the earth is not rigid but is presumably plastic under the action of long-continued forces. Therefore, the result of such an increase in the speed of rotation or in tidal action would be merely an increase in the flattening, to which the earth would adjust itself by plastic flow or by ruptures here and there, the continents remaining in the same general relative position with respect to their surroundings.

There is, however, a small residual equatorward force that acts on an object floating on the earth's surface. It is due to the change in direction of gravity with elevation and is approximately proportional to the distance between the center of gravity and the center of buoyancy of the floating body. This force is invoked by Wegener as an explanation of the equatorward movement of a continental block of "sial" floating in "sima." The force is so small (about 1/1,000,000 of gravity) that it seems inadequate to overcome the resistance of the "sima." In rebuttal to this objection it is urged that a very small force acting through geologic ages might produce considerable effects, since, in the yielding of a viscous liquid, time is the all-important element rather the magnitude of the force. This argument assumes that so-called solids like the "sima" are really extremely viscous liquids. There is, however, a real distinction between soft solids and viscous liquids, as was pointed out long ago by Clerk Maxwell, and as has been more recently verified by Bingham and Durham. It seems far more probable that the "sima" is a solid with a yield-point well above the stresses due to this extremely minute equatorward force than that it is a viscous liquid; if the "sima" is a true solid, the force in question would be ineffective in producing equatorward displacements of the continents.

The fact that the higher portions of the earth's crust are lighter than the deeper-lying portions and the hypothesis of isostasy based on this fact both suggest the conception of floating continental blocks, of which Wegener has made such free use. But this whole hypothesis of a floating crust is rather a convenient simile than an adequate statement of all the facts, and must not be pressed too far. On the hypothesis of isostasy the stresses in the crust are not hydrostatic (that is, such as occur in flotation) until the depth of com-

pensation is reached. The assumption of an absolutely rigid continental block floating in a liquid is therefore an unsatisfactory basis for calculating the stresses involved.

Taylor's conception of the continental migration makes it mainly toward the equator. Wegener conceives of it as mainly westward and suggests that this westward movement may be due to the deflecting force of the earth's rotation which would result from an equatorward movement. On the most favorable assumptions, however, the equatorward movement is so slow that this explanation is entirely inadequate.

The hypothesis of continental migration is a serious attempt to coordinate and explain facts that need explanation, but the suggested mechanical explanations of the migration are unconvincing. Till some more adequate explanation is offered, mathematicians and physicists are likely to doubt the validity of the hypothesis. (*Author's abstract*).

180TH MEETING

The 180th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club, the evening of Thursday, October 18, 1923. Dr. ALEŠ HRDLIČKA, Curator, Division of Physical Anthropology, U. S. National Museum delivered an address on *Ancient man in Europe*.

The speaker, who had just returned from his third trip over the field of ancient man in Europe, gave a general account of his impressions, of the principal discoveries, and of the present status of research and opinion relating to Early Man.

The strongest impressions brought back are those of the vastness of the European territories and deposits yielding cultural and even skeletal remains of geologically ancient man; of the amount of work, particulrly that of an archeological nature, which has already been done in this field; of the far greater amount of work still to be done; and of the peculiar neglect of the field by American scientists, with the great opportunities for American participation now and in the future.

As the material evidence of man of different ages together with that of the contemporary fauna and the geological deposits accumulates, former conceptions in all these lines are changing. There is, especially, a growing uncertainty as to the subdivisions and duration of the Glacial Age. The problems of continuous or interrupted human evolution and progress, of the number of human varieties and races in the past, of the fate of some of them, and of the derivation of others that seem to have come from elsewhere, are all slowly being worked out; but in some if not all these respects anthropology is still far from a definite solution. There are many opinions, some of them held very tenaciously, but they are more or less premature. Much additional light is needed, light to be secured through systematic and thoroughly scientific work, such as is now being carried on at a few sites, especially in southern France.

What is demonstrated is that man has existed in Europe throughout or nearly throughout the Quaternary, and that he has in a large measure, if not entirely, developed there both culturally and physically.

In conclusion, Dr. HRDLIČKA, who among other results of his last journey was honored by being the first American scientist privileged to examine the original remains of the *Pithecanthropus*, again stressed the opportunities for American participation in active research in this great European and Old

World field; such participation would be welcomed and would exert a wholesome, stimulating influence in many directions.

The lecture was illustrated by charts and by photographs of a series of the most important localities where ancient skeletal remains of man were discovered.

WILLIAM R. MAXON, *Recording Secretary.*

THE BOTANICAL SOCIETY

165TH MEETING

The 165th meeting was held at the Cosmos Club, February 6, 1923, at 8 p.m. with Dr. H. L. SHANTZ in the chair, and 31 persons present.

Program: Dr. PERLEY SPAULDING: *Notes on some tree diseases in Europe.* (Illustrated.) *Melampsorella elatina* causes cankers on the trunks of *Abies pectinata* which greatly reduce the timber value. *Fomes annosus* causes root rot especially of *Abies pectinata*, in some places preventing the use of this species. *Cronartium ribicola* is generally distributed in Europe wherever *Pinus strobus* occurs. It is exterminating this species as well as *P. monticola* and *P. flexilis*, both of which are more susceptible than is *P. strobus*. *Pinus excelsa* is quite resistant and may well be substituted for *P. strobus*, not only in Europe but in North America. Trees of *P. strobus* from 4 to 118 years of age were killed by this fungus, age giving no degree of immunity. *Dasyscypha willkommii* attacks the larches in Great Britain, but a new hybrid larch is not only immune to this disease but is the fastest growing larch known there. *Robinia pseudacacia*, wrecked in America by *Fomes robiniae* and a wood borer, is a real tree in Europe because these two enemies have been left behind in America.

N. REX HUNT: *Steam and chemical soil disinfection.* A cheap, effective, practicable method of soil disinfection is needed to exterminate the potato wart disease before it spreads to important potato growing regions. Potato wart extermination methods were studied at Freeland, Pa., and Washington, D. C., 1920–22 by F. G. O'Donnell, Rush P. Marshall, and the speaker. The inverted steam-pan method was found fairly effective but expensive and impracticable for large scale use. A pressure regulator was found to insure more uniform treatment of soil. Soil temperature changes brought about by steaming were determined. Fourteen chemical treatments, ranging upward from $250.00 per acre in cost, were found effective against wart, mercuric chloride, borax, chloride of lime, copper sulphate, sodium carbonate, sodium fluoride, and sulphur were used dry. Kerosene and crude oil were used undiluted. Effective solutions were mercuric chloride, Bordeaux, cleaning solution, lime sulphur, sodium chromate, and Fairmount weed-killer. Some chemicals were applied to the surface and some were worked into the soil. The variable growth of potato plants in these treated plots is recorded. The effect of the treatments on the hydrogen-ion readings of the soil was recorded. A study of the effect of treatments on the soil flora was begun.

The influence of soil moisture and soil type on the penetration of some chemicals was determined and found to be very important. The addition of sodium chloride increased the penetration of mercuric chloride remarkably. Better penetration and more uniform distribution of this solution is secured by applying all chemicals in part of the water, and then applying the remainder of the water. Kerosene penetrates several times as well in damp as in dry soil. The various groups of data secured have a very practical bearing

on the problem of field treatments. A bibliography of 3,000 titles has been assembled. A better knowledge of the fundamental principles governing soil treatments, is greatly needed to aid in the solution of an ever increasing number of soil treatment problems.

166TH MEETING

The 166th meeting was held Tuesday, March 6, 1923, in the Crystal Dining Room of the New Ebbitt Hotel with 146 persons present.

Following dinner, Dr. W. E. Safford, the retiring President, gave an address on *Economic botany as a means of determining the origin and dissemination of primitive tribes.*

Dr. A. F. Woods, President of the University of Maryland and first President of the Botanical Society of Washington, was present as guest of honor.

After the address there was dancing.

Roy G. Pierce, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

F. E. Matthes, of the U. S. Geological Survey, gave a lecture on November 3 before the Brooklyn Institute of Arts and Sciences on *The cliffs and waterfalls of the Yosemite Valley.*

T. Wayland Vaughan and A. H. Brooks, who represented the Geological Survey at the Pan-Pacific Scientific Congress in Australia, have returned to Washington.

Paul C. Standley, of the National Museum, left recently for Panama, where he is to continue the investigation of the flora of the Canal Zone, a work commenced several years ago.

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GEOPHYSICS.—*The density of the Earth as calculated from the densities of Mauna Kea and Haleakala.* Henry S. Washington, Geophysical Laboratory.[1]

Of the various methods for determining the mean density of the Earth the oldest is that of measuring the attraction exerted by an isolated mountain. This was employed at Chimborazo by Bouguer as early as 1749, next at Schiehallion by Maskelyne and Hutton in 1775, and later by others at other mountains.[2] The method is open to very serious objections, as pointed out by Boys; difficulty in measuring the geometrical form and mass of the mountain, and ignorance or uncertainty as to the homogeneity or distribution in heterogeneity, the solidity of the mountain, and the character of the underlying crust of the Earth. This method, indeed, has been superseded by those based on laboratory experiment, such as with the torsion balance or the chemical balance.

The last geodesist to use the "mountain observation" method for the determination of the mean density of the Earth (Δ) was E. D. Preston, of the U. S. Coast and Geodetic Survey, in connection with pendulum and latitude observations at Mauna Kea on the Island of Hawaii[3] in 1892.

In the course of a recent petrological study of the lavas of the Island of Hawaii I determined the specific gravities of the specimens that I analysed, including those of Mauna Kea,[4] and was struck with the discrepancies between my specific gravities and their average and those given by Preston, as well as the resulting values for the density of the Earth.

[1] Received Nov. 26, 1923.

[2] Cf. C. V. Boys in Glazebrook, A dictionary of applied physics, **3**: 279. 1923.

[3] E. D. Preston, U. S. Coast and Geodetic Survey, Report for 1893, Appendix No. 12, pp. 625–634. 1894.

[4] H. S. Washington, Amer. Journ. Sci. **5**: 487–502. 1923; and Amer. Journ. Sci. **6**: 361. 1923.

The specimens of lava that Preston collected at Mauna Kea were examined by Merrill,[5] who determined the specific gravities of fourteen of them, the average being 2.63. This is very low and is accounted for by the fact that many of the specimens were vesicular or not fresh, as pointed out by Merrill. From his pendulum observations and estimates of the altitude and radius of the base of the mountain, Preston calculates the value $\delta = 0.565\Delta$; in which δ is the average density of the rocks and Δ is the average density of the Earth. The value given is the mean between those arrived at on the assumption that the attraction of the mountain is the mean between that of an infinite plane and of a cone. Using Merrill's average specific gravity the mean density of the Earth is, therefore, calculated to be 4.655, a figure far below the accepted value. Preston, however, does not use Merrill's data alone but combines these with the specific gravities of lavas from Mauna Loa and Kilauea, as determined by E. S. Dana.[6] He thus arrives at the average Mauna Kea rock specific gravity 2.90 and the value 5.13 for the mean density of the Earth, this last being also much below that generally accepted, which may be taken as 5.52.[7]

I determined the specific gravities of nine specimens of the Mauna Kea rocks, some of whole hand specimens with the balance and others of the rock powder with the pycnometer.[8] The results, with two determined by Daly,[9] are given in Table I, with the calculated densities. The specific gravity No. 1 (2.870) is a new determination of that of the andesite of Laupahoehoe, the previously published value (2.709)[10] having been too low because of the vesicularity of the specimen. No. 10 (2.959), of the olivine basalt of Kaula Gulch, is also new. These results give an average specific gravity of 2.969 and an average density of 2.963; hence, using Preston's value $\Delta = 1.77\delta$, $\Delta = 5.245$. This is much higher than the value (4.655) obtained from the specific gravities of Preston's specimens, and somewhat higher than that (5.13) calculated by Preston, but is still much below the generally accepted value.

Regarding these results some comment is called for. Preston seems to have selected more or less vesicular specimens because he

[5] G. P. Merrill in Preston, *op. cit.*, 630.

[6] E. S. Dana, Amer. Journ. Sci. **37**: 441. 1889.

[7] Cf. the value (5.525) selected by Burgess (Boys in Glazebrook, *op. cit.*, p. 285); also Williamson and Adams, Journ. Washington Acad. Sci. **13**: 413. 1923.

[8] The pycnometer determinations on the rock powder are consistently higher than those made on the hand specimens.

[9] R. A. Daly, Journ. Geol. **19**: 208 and 301. 1911.

[10] H. S. Washington, Amer. Journ. Sci. **5**: 490. 1923.

appears to have thought, judging from the conspicuous flows on the surface, that they represented well the bulk of the rocks of the volcano. In this I think that he is in error, because my examination of the deep ravines cut by erosion in the eastern flank of Mauna Kea showed "the almost complete absence of ash and scoria beds" and the overwhelming prevalence of compact or but very slightly vesicular forms of lava among the interior flows. It is therefore probable that my specimens, most of which were compact or in which vesicularity was compensated for by pulverization, represent the mass of the volcano far better than do Preston's surface specimens of pahoehoe or the rough aa crust, conspicuous forms that a non-geologist would naturally collect.

In the next place, Preston seems to be scarcely justified in using Dana's data for Mauna Loa and Kilauea in discussing the density of Mauna Kea. My recent study has shown that the general petrographical and chemical characters and the average densities of the five volcanoes on Hawaii are markedly different the one from the other. Thus, to confine our attention only to densities, I obtained the average specific gravity 2.969 for Mauna Kea, 2.932 for Kilauea, 2.953 for Mauna Loa, and 2.940 for the whole island of Hawaii. The differences are not great, but they are so marked that they should be taken into account.

Five years earlier than his study at Mauna Kea, Preston,[11] from pendulum observations at Haleakala on Maui, obtained the value $\delta = 0.48\Delta$ at this volcano, which was considered as a cone. From this, accepting the value of Δ as 5.67, he calculates the average density of the rocks of Haleakala as 2.72.

This average specific gravity seems much too low, and that derived from the specimens that he collected, (2.21) is certainly far below the true value, as may be seen from the individual specific gravities and from Merrill's descriptions, which indicate that most of Preston's Haleakala specimens were either very vesicular or not fresh. I have therefore determined the densities of nine specimens of lava from Haleakala that were collected in 1920 by Dr. J. Allan Thomson and kindly given by him to me for study.[12] The freshest, most compact, and the most representative specimens, so far as could be judged without microscopical examination, were selected. The determina-

[11] E. D. Preston in U. S. Coast and Geodetic Survey, Report for 1888, Appendix No. 14, p. 530. 1889. He gives a slightly lower value (0.43) in Amer. Journ. Sci. **36**: 311. 1888.

[12] These will be described, with analyses, in a forthcoming paper in my series on the petrology of the Hawaiian Islands.

tions were all made on whole hand specimens with the balance, inclosed air being expelled by exposure in water to a pressure of about 2 cm., and subsequent soaking for eight hours before weighing in water.

The results, given in Table I, indicate that the average density of the rocks of Haleakala is 2.812, which is markedly lower than that of Mauna Kea (2.963). From this Haleakala density the mean density of the Earth, using Preston's value $\delta = 0.48\Delta$ for Haleakala, would be 5.877, a figure that is about as much above the accepted value as that derived from the Mauna Kea data is below it. The average of the two values for Δ, based on my specimens from Mauna Kea and Haleakala, is 5.560, which is fairly close to the accepted value.

TABLE I

MAUNA KEA			HALEAKALA		
Sp. gr.	C°	Density	Sp. gr.	C°	Density
2.870	21°	2.864	2.706	25°	2.698
2.911	(Daly)	2.911	2.734	25°	2.726
2.761	(Daly)	2.761	2.924	25°	2.915
2.982	22.3°	2.976	2.836	25°	2.828
3.040	22°	3.033	2.929	25°	2.920
3.018	22.3°	3.010	2.788	25°	2.780
2.994	22.3°	2.987	2.718	25°	2.710
2.972	17°	2.968	3.067	25°	3.058
2.978	22.3°	2.971	2.680	25°	2.672
2.959	20.2°	2.954			
3.164	25°	3.158			
Average 2.969		2.963	2.820		2.812

SCIENTIFIC NOTES AND NEWS

The death is announced of Rev. JOHN THOMPSON HEDRICK, at St. Andrew-on-Hudson, Poughkeepsie, N. Y., October 24. Dr. Hedrick was formerly director of the Georgetown University Observatory. He was a generous contributor to astronomical publications and an accepted authority on the subjects upon which he wrote.

A "get together meeting" of the Society of the Sigma Xi of Washington and vicinity was held at the Cosmos Club on November 22, 1923. Ten-minute talks on *The most interesting thing I have seen the past summer* were made by various members, including L. O. HOWARD on the Wellcome Medical Historical Museum in London, PAUL BARTSCH on under-water "movies" in the Bahamas, H. L. SHANTZ on botanical excursions in Switzerland, E. E. SLOSSON (president of the local Society) on electrification in Sweden, W. T. LEE on the newly explored enormous caves in New Mexico, E. D. BALL on petrified forests in the Bad Lands. CHARLES BROOKS, of the Department of Agriculture is secretary.

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A † denotes the abstract of a paper presented before the Academy or an affiliated Society. A § indicates an item published under the head Scientific Notes and News.

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ANNOUNCEMENTS OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Saturday, January 6 The Biological Society.

Wednesday, January 10. The Geological Society.

Thursday, January 11. The Chemical Society, at the Cosmos Club at 8 p m Program.

R. C. WELLS: *Chemistry of the sea* (Presidential address.)

Saturday, January 13 The Philosophical Society.

Tuesday, January 16. The Anthropological Society.

Wednesday, January 17. The Society of Engineers.

Thursday, January 18. The ACADEMY.

PROGRAMS ANNOUNCED SINCE THE PRECEDING ISSUE OF THE JOURNAL[1]

Thursday, December 7. The Entomological Society, at the National Museum, at 8 p.m. Program: Election of officers. ARTHUR G. BOVING: *Biology of blister beetles.* J. N. ALDRICH: *A manuscript bibliography of S. W. Williston.*

Wednesday, December 13. The Geological Society, at the Cosmos Club, at 8 p.m. Program: WILLIAM C. ALDEN: *The physiographic development of the Northern Great Plains.* (Presidential address.)

Thursday, December 21. Joint meeting of the ACADEMY and the Philosophical Society, at the Cosmos Club, at 8.15 p m. Program: H. A. CLARK: *The manufacture of thermometers.*

[1] Notices received too late for publication before the date of the meeting.

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E. DE MARGERIE (Chief geologist of Alsace Lorraine): *The structure of the Alps.*

Saturday, January 27. The Philosophical Society.

Thursday, February 1. The Entomological Society.

Saturday, February 3. The Biological Society.

PROGRAMS ANNOUNCED SINCE THE PRECEDING ISSUE OF THE JOURNAL[1]

Thursday, December 7. The Entomological Society, at the National Museum, at 8 p.m. Program: Election of officers. ARTHUR G. BOVING: *Biology of blister beetles.* J. N. ALDRICH: *A manuscript bibliography of S. W. Williston.*

Wednesday, December 13. The Geological Society, at the Cosmos Club, at 8 p.m. Program: WILLIAM C. ALDEN: *The physiographic development of the Northern Great Plains.* (Presidential address.)

Thursday, December 21. Joint meeting of the ACADEMY and the Philosophical Society, at the Cosmos Club, at 8 15 p m. Program: H. A. CLARK: *The manufacture of thermometers.*

[1] Notices received too late for publication before the date of the meeting.

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Saturday, February 10. The Philosophical Society.

Tuesday, February 13. The Society of Electrical Engineers.

Wednesday, February 14. The Geological Society.

Thursday, February 15. The Washington Academy.

W. D. Collins, Geological Survey: *Industrial aspects of modern methods of water purification* (Illustrated)

Saturday, February 17. The Biological Society.

PROGRAMS ANNOUNCED SINCE THE PRECEDING ISSUE OF THE JOURNAL[1]

Tuesday, January 9. The Washington Academy of Sciences, at the Carnegie Institute, 8.15 p.m. Program: W. J. Humphreys: *The murmur of the forest and roar of the mountain* (presidential address); election of officers.

Wednesday, January 10. The Geological Society, at the Cosmos Club, at 8 p.m. Program: A. J. Collier: *Some features of the geology of the Little Rocky Mountains.* M. R. Campbell: *The Pulaski overthrust fault in southwestern Virginia.* N. H. Darton: *Some Arizona problems.*

Saturday, January 13. The Philosophical Society, at the Cosmos Club, at 8.30 p.m. Program: E. C. Crittenden. *The measurement of light* (presidential address).

[1]Notices received too late for publication before the date of the meeting.

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President: T. WAYLAND VAUGHAN, U. S. Geological Survey.

Corresponding Secretary: FRANCIS B. SILSBEE, Bureau of Standards.

Recording Secretary: WILLIAM R. MAXON, National Museum.

Treasurer: R. L. FARIS, Coast and Geodetic Survey.

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Wednesday, February 28. The Geological Society.
Thursday, March 1. The Entomological Society.
Saturday, March 3. The Biological Society.

PROGRAMS ANNOUNCED SINCE THE PRECEDING ISSUE OF THE JOURNAL[1]

Tuesday, January 9. The Washington Academy of Sciences, at the Carnegie Institute, 8.15 p.m. Program: W. J. HUMPHREYS: *The murmur of the forest and roar of the mountain* (presidential address); election of officers.

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Saturday, January 13. The Philosophical Society, at the Cosmos Club, at 8.30 p.m. Program: E. C. CRITTENDEN: *The measurement of light* (presidential address).

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Tuesday March 13. The Electrical Engineers.
Wednesday, March 14. The Geological Society.
Thursday, March 15. The ACADEMY.
Saturday, March 17. The Biological Society.

PROGRAMS ANNOUNCED SINCE THE PRECEDING ISSUE OF THE JOURNAL

Thursday, February 1. The Entomological Society, at the National Museum, at 8 p.m. Program: E. G. SMITH: *A trip into Mexico for parasites of the bean leaf beetle.* A. C. BAKER: *A history of the study of plant lice.*

Thursday, February 8. The Chemical Society, at the Cosmos Club, at 8 p.m. Program: E. V. MCCOLLUM: *What has been learned about nutrition in a decade.*

Saturday, February 10. The Philosophical Society, at the Cosmos Club, at 8 p.m. Program: G. W. LITTLEHALES: *New researches to lighten the labor of navigators in finding geographical position from observations of celestial bodies* (illustrated). C. V. HODGSON: *Precise measurement of distances on the earth* (illustrated). R. W. G. WYCKOFF: (1) *Atomic radii.* (2) *Crystal structures of the alums* (illustrated).

Wednesday, February 14. The Geological Society, at the Cosmos Club, at 8 p.m. Program: FRANK REEVES: *Geological structure of the Bearpaw mountains* (illustrated). W. T. THOM: *Origin of the structural features of Montana and Wyoming* (illustrated).

Thursday, February 15. The Washington Academy, at the Cosmos Club, at 8.15 p.m. Program: W. D. COLLINS: *The industrial aspects of modern methods of water purification.*

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Tuesday, March 20. The Anthropological Society.
Wednesday, March 21. The Society of Engineers.
Saturday, March 24. The Philosophical Society.
Wednesday, March 28. The Geological Society.
Saturday, March 31. The Biological Society.
Tuesday, April 3. The Botanical Society.

PROGRAMS ANNOUNCED SINCE THE PRECEDING ISSUE OF THE JOURNAL

Thursday, February 1. The Entomological Society, at the National Museum, at 8 p.m
Program: E. G. SMYTH: *A trip into Mexico for parasites of the bean leaf beetle* A. C. BAKER: *A history of the study of plant lice.*

Thursday, February 8. The Chemical Society, at the Cosmos Club, at 8 p.m.
Program: E. V. McCOLLUM: *What has been learned about nutrition in a decade.*

Saturday, February 10. The Philosophical Society, at the Cosmos Club, at 8 p.m.
Program: G. W. LITTLEHALES: *New researches to lighten the labor of navigators in finding geographical position from observations of celestial bodies* (illustrated). C. V. HODGSON: *Precise measurement of distances on the earth* (illustrated). R. W. G. WYCKOFF: (1) *Atomic radii.* (2) *Crystal structures of the alums* (illustrated).

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Thursday, February 15. The Washington Academy, at the Cosmos Club, at 8.15 p.m.
Program: W. D. COLLINS: *The industrial aspects of modern methods of water purification.*

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Wednesday, April 11. The Geological Society.
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Saturday, April 14. The Biological Society.
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Tuesday, April 17. The Anthropological Society.
Wednesday, April 18. The Engineering Society.

PROGRAMS ANNOUNCED SINCE THE PRECEDING ISSUE OF THE JOURNAL

Thursday, February 1. The Entomological Society, at the National Museum, at 8 p.m. Program: E. G. Smyth: *A trip into Mexico for parasites of the bean leaf beetle.* A. C. Baker: *A history of the study of plant lice.*

Thursday, February 8. The Chemical Society, at the Cosmos Club, at 8 p.m. Program: E. V. McCollum: *What has been learned about nutrition in a decade.*

Saturday, February 10. The Philosophical Society, at the Cosmos Club, at 8 p.m. Program: G. W. Littlehales: *New researches to lighten the labor of navigators in finding geographical position from observations of celestial bodies* (illustrated). C. V. Hodgson: *Precise measurement of distances on the earth* (illustrated). R. W. G. Wyckoff: (1) *Atomic radii.* (2) *Crystal structures of the alums* (illustrated).

Wednesday, February 14. The Geological Society, at the Cosmos Club, at 8 p.m. Program: Frank Reeves: *Geological structure of the Bearpaw mountains* (illustrated). W. T. Thom: *Origin of the structural features of Montana and Wyoming* (illustrated).

Thursday, February 15. The Washington Academy, at the Cosmos Club, at 8.15 p.m. Program: W. D. Collins: *The industrial aspects of modern methods of water purification.*

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Corresponding Secretary: Francis B. Silsbee, Bureau of Standards.

Recording Secretary: William R. Maxon, National Museum.

Treasurer: R. L. Faris Coast and Geodetic Survey

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Saturday, April 28. The Biological Society.

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Thursday, April 5. The Entomological Society, at the National Museum, at 8 p.m. Program: PEREZ SIMMONS: *The housefly plague in American expeditionary force.* C. C. HAMILTON: *Biology of tiger beetles.*

Saturday, April 7. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program: C. W. KANOLT: *Liquid and solid hydrogen.* N. H. HECK: *Relation of seismology to geodesy and tides.* J. E. IVES: *On the nature of the illumination used by engravers of steel plates.*

Tuesday, April 10. The Geological Society, special meeting, at the auditorium of the Interior Building. Program: *Geology as seen from the air.*

Wednesday, April 11. The Geological Society, at the Cosmos Club, at 8 p.m. Program: KIRK BRYAN: *Pedestal rocks near Lee's Ferry, Arizona.* J. D. SEARS: *Relation of the Brown's Park formation and the Bishop conglomerate and their role in the origin of Green River.* FRANK L. HESS: *Uses of the rarer metals.*

Tuesday, April 17. Joint meeting of the ACADEMY, Philosophical Society, and Chemical Society, at the auditorium of the Interior Building, at 8.30 p.m. Program: Remarks on their recent researches in chemistry by DR. F. G. DONNAN, University College, London, and DR. J. C. IRVINE, University of St. Andrews.

Wednesday, April 18. Joint meeting of the ACADEMY, Geological Society, and Philosophical Society, at the auditorium of the Interior Building, at 8.15 p.m. Program: Symposium on *The Taylor-Wegener hypothesis.* FRANK B. TAYLOR: *The lateral migration of land masses.* R. A. DALY: *A critical review of the hypothesis.* W. D. LAMBERT: *The mechanics of the hypothesis.* FRED. E. WRIGHT: *Report of the symposium at the meeting of the British Association.*

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Wednesday, May 23. The Geological Society.
Saturday, May 26. The Biological Society.

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Thursday, May 3. The Entomological Society, at the National Museum, at 8 p.m. Program: G. F. White: *On the diseases of insects.* J. M. Aldrich: *A unique egg laying apparatus in the Tachinid fly.*

Saturday, May 5. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program: C. LeRoy Meisinger: *Free air pressure maps and their accuracy.* J. P. Ault: *Aerial navigation.*

Wednesday, May 9. The Geological Society, at the Cosmos Club, at 8 p.m. Program: William Bowie: *The theory of isostasy and its significance in geology.*

Thursday, May 10. The Chemical Society, at the Cosmos Club, at 8 p.m. Program: Stunt Night.

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Saturday, October 20. The Philosophical Society.

Wednesday, October 24. The Geological Society.

Thursday, October 25. The Chemical Society, at the Cosmos Club, 8 p.m. Program: J. W. McBain: *A study of soap solutions and its bearing on colloid chemistry.*

Saturday, October 27. The Biological Society.

Thursday, November 1. The Entomological Society.

Saturday, November 3. The Philosophical Society.

PROGRAMS ANNOUNCED SINCE THE PRECEDING ISSUE OF THE JOURNAL

Thursday, October 4. The Entomological Society, at the National Museum, at 8 p.m. Program: L. O. Howard: *Notes on a recent trip to Europe.*

Saturday, October 6. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program: F. Wenner and A. W. Smith: *The measurement of low resistance by the Wheatstone bridge.* Edward H. Bowie: *Worldwide synoptic meteorological charts, and some inferences based thereon.* R. B. Sosman and H. E. Merwin: *The effect of fine grinding on the density of quartz.*

Thursday, October 11. The Chemical Society, at the Cosmos Club. Program: E. W. Washburn: *Physical chemistry and ceramics.*

Thursday, October 18. The Academy, at the Cosmos Club. Program: Aleš Hrdlička: *Ancient man in Europe.*

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Wednesday, November 14. The Geological Society.

Thursday, November 15. THE ACADEMY, at the Cosmos Club. Program:
J. C. MERRIAM: *The origin and development of the Pan-Pacific science congresses. The Australian meeting in 1923.* T. WAYLAND VAUGHAN: *Proceedings.* H. E. GREGORY: *The resolution adopted by the Congress and international cooperation in scientific* [illegible]

Saturday, November 17. The Philosophical Society.

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Saturday, October 20. The Philosophical Society, at the Cosmos Club. Program:
LEWIS V. JUDSON: *The work of the International Bureau of Weights and Measures.* PAUL R. HEYL: *Gravitational anisotropy in crystals.*

Saturday, November 3. The Philosophical Society, at the Cosmos Club. Program:
L. B. TUCKERMAN: *A new optical lever system.* O. H. GISH: *The system for recording earth currents at the Watheroo Magnetic Observatory.*

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Saturday, November 10. The Biological Society, at the Cosmos Club. Program: W. B. Greeley: *The relation of National Forest management to wild life.* L. O. Howard: *A recent visit to certain European centers*

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